BEHAVIORAL AND ATTITUDINAL DIFFERENCES OF CONSUMERS AMID DROUGHT AND NON-DROUGHT CONDITIONS

A Dissertation

by

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ABSTRACT

Water is becoming scarcer as the world population increases and will be allocated among competing uses. The strain on potable water supplies heightens the competition for water resources and potentially reduces demand for outdoor plantings and landscaping. We conducted an online survey with 1,543 respondents in 2016 to assess perceptions about landscape plants, homeowner water conservation and plant expertise; their involvement in water conservation and plant issues; and the importance of plants and landscaping. We also collected demographic characteristics. Subjects were categorized based on their drought status via the U.S. Drought Monitor and perceived drought status. Using two separate conjoint designs, we assessed their perceptions of both herbaceous and woody perennials. Factor and cluster analyses were used to derive underlying beliefs about involvement, expertise, and active and passive enjoyment within the landscape.

Consumers placed greater relative importance in the decision-making process on water source in production over other attributes for herbaceous perennials and not woody perennials. Additionally, the group that did not perceive a drought but experienced one, placed a higher value on nursery plants grown with fresh water compared to those who were actually not in drought and did not perceive one. Cluster analysis findings suggest that pro-water conserving attitudes are found among consumers who value outdoor landscapes and those individuals who spent more on plants. Results suggest that educational and promotional efforts may improve the perception of recycled water. Producers and retailers should focus marketing and communication efforts on low water use cultivar selection and operationalizing water conserving behaviors more than convincing consumers that plant purchases and landscaping are important.

DEDICATION

For my parents, Dale and Glenda, and my siblings, Stacia and Dean, who always see the best in me and encourage me to pursue learning no matter the adversity.

“The grass withereth, the flower fadeth:

but the Word of our God will stand for ever.”

Isaiah 40: 8

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[The data analyzed for Chapters 1, 2, 3, and 4 was not collected from Texas A&M University but was collected through Michigan State University under IRB# x16-1053e Category: Exempt 2 before the student's dissertation program began. The student did not craft the survey, was not part of the grant, and had no interaction with research subjects or access to identifiable data. The student only analyzed de-identified data.]

Part 2, student/collaborator contributions

All work for the dissertation was completed by the student, in collaboration with Charles R. Hall of the Department of Horticultural Sciences.at Texas A&M University and Bridget K. Behe of the Department of Horticultural Sciences at Michigan State University.

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1. INTRODUCTION

North American has a vast amount of available fresh water. In fact, the United States alone has the third largest freshwater river in the world, holds three of the seven largest bodies of fresh water in the world within its borders (Lake Superior, Michigan, and Huron), and one of the largest freshwater aquifers in the world (Ogallala Aquifer). But with all of this seemingly available water, there are still areas across the nation that experience scarcity. States such as California, Nevada, and Arizona have recently undergone multi-year droughts that deplete their already-dwindled water resources. States that experience acute drought, such as Texas, North Dakota, and Georgia, are not only strained in terms of their available water resources, but it affects those states economically as well. Taking into account water use in public supply, domestic, agriculture, industry, mining, and thermoelectric power, across the board, there are significant demands on our water resources and this situation can be exacerbated by weather conditions and human behaviors.

The human side of the issue requires homeowners and municipal leaders to take responsibility in the form of accountable actions to alleviate the strain put on our water resources, especially during drought. As more of the population urbanizes and concentrates in the United States, there will likely be more restrictive water-related regulations in those areas due to the dense population and finite water resources. Thus, water conservation policy should be expected to be more contentious when looking into the future.

Studies have shown that water application among commercial and residential users is most variable with respect to outdoor use (e.g. outdoor pools or saunas, public and private gardens and improved landscapes, or any outdoor activity). Considering this, how can water conservation practices be better applied to outdoor water usage? Simultaneously, how can green industry associations/participants assist in the implementation of water conservation practices by commercial property owners and residential homeowners? These questions require an investigation into the need for water conservation practices by these water users and how do they apply that information in making decisions about outdoor landscape water use.

To accomplish this, we must first look at how water consumers think and feel about water and their habits when it comes to water scarcity. Indoor water usage is considered stable due to the low variability of water utilized from season to season, but outdoor water usage is highly variable as water use fluctuates greatly with seasonal changes. Where there is variability, there can be change. This proposed research consists of a four-part analysis to help decipher how homeowners behave when considering water conservation practices and if their attitudes align with their behavior. This involves answering the following questions:

- Do consumers' attitudes differ if the area in which they live is experiencing drought conditions versus if they are not in drought?
- Does a lack of knowledge about past or current drought conditions play any role in their attitudes?
- When thinking of buying a plant, what is the most important attribute about that plant that influences their decision (e.g. the way it is grown, the type of water used to irrigate, price, or plant species)? Does this differ between perennials and landscape trees?

- When asked about water conservation, does involvement in and expertise of water conservation play a role? Can these attributes be categorized to be more specific?
- Do consumers who know they are in drought and have accurate knowledge of their current drought condition and consumers who are involved water conservation have the same attitudes about water-saving plant products

2. CONSUMER PERCEPTIONS, ATTITUDES, AND PURCHASE BEHAVIOR WITH LANDSCAPE PLANTS DURING REAL AND PERCEIVED DROUGHT PERIODS*

In the coming decades, no natural resource may prove to be more critical to human health and well-being than water (Degefu et al., 2018). There is abundant evidence that the condition of water resources in many parts of the United States is deteriorating (Vörösmarty et al., 2000). In some regions of the country, the availability of sufficient water to meet growing domestic uses, and the future sufficiency of water to support the use of landscape plants where we live, work, and play is in doubt. Conservation through water efficiency measures and water management practices may be the best way to help resolve water problems. Yet, consumer perceptions, attitudes, and behaviors regarding water conservation may differ widely, particularly in the presence of drought. This study seeks to add to the current horticulture and water conservation literature by exploring consumer attitudes and behavior during real and perceived drought situations, especially in terms of their landscape purchases and gardening/landscaping activities. Study findings could better inform educational programs and marketing strategies, helping to ensure the future demand of green industry products and services.

2.1 Literature Review

Water is essential for all life, including plants, and approximately 40% to 70% of U.S. water is used in urban areas (Spinti et al., 2004; St. Hilaire et al., 2008). Springer

*Reprinted with permission from "Consumer Perceptions, Attitudes, and Purchase Behavior with Landscape Plants during Real and Perceived Drought Periods" by Knuth, M., Behe, B. K., Hall, C. R., Huddleston, P. T., & Fernandez, R., 2018. HortScience, 53(1), 49-54, Copyright [2018] by American Society of Horticultural Sciences.

(2011) reported that the average U.S. household used approximately 69 gallons of water per capita daily in 2006. Globally, nearly 40% of food resources come from irrigated land (Somerville and Briscoe, 2001). Water resources will become scarcer as the world population increases (Springer, 2011), which will have an impact on how and where we use water. If consumer attitudes and behaviors severely reduce or eliminate landscape water use, it will have a widespread and detrimental effect on the Green Industry. The current climate is ideal to discover the role of consumer attitudes and perceptions of water use and source with regard to landscape plants. These discoveries can be used to better inform educational and marketing efforts to help sustain the green industry during drought periods.

Household water usage in the U.S. is greatly affected by water shortages. The U.S. Geological Survey (USGS) estimates domestic water usage every five years. In 2010 (last survey administered) the total freshwater withdrawals were estimated to be 355 billion gallons per day, which represented 86% of total withdrawals (Maupin et al., 2014). Over 42,000 million gallons of water per day is drawn for public water usage for 286 million people. Public water is any water drawn for domestic, commercial, and industrial needs. Of public water, domestic water usage represents 57% and is classified as all water used for non-agricultural or industrial purposes excluding all water not used in households. Sixty-three percent of the water drawn for public supply was from surface sources, such as rivers and lakes, while 37% was from groundwater.

The Columbia Water Project (Alfredo, 2016) brings to light much of the groundwater deficit the U.S. is experiencing. In the states of Arizona, California, Illinois, Indiana, Iowa, Kansas, Minnesota, North Dakota, Oklahoma, South Dakota and parts of

Texas, Michigan, and Wisconsin there is a Normalized Deficit Cumulated (NDC) > 5. NDC is the maximum cumulative water deficit between supply and demand as a ratio to its average annual precipitation (Alfredo, 2016). The NDC is important because it shows the level of replenishment of groundwater resources versus annual withdrawal. Ground water removal is increasing in states that have high multi-year drought such as Arizona, California, and Texas. In those areas, groundwater levels are falling.

Recent work indicates that attitudes and behavior towards potable water supplies have changed somewhat due to greater social awareness and increasingly widespread exposure to drought conditions (Beal et al., 2013). Education about and adoption of sustainable water use practices will ensure an adequate supply of quality landscape water while conserving water sources for human and ecosystem services (Beal et al., 2013). It is important to analyze consumer perceptions of water scarcity versus actual water scarcity because past literature has shown there is a deficit in homeowner knowledge concerning their actual water usage. Perceptions may, and often do, differ from reality and should be analyzed separately. By stepping into the dialogue with more evidence of behavioral differences among those who perceive to be in drought, and those who do not, we can contribute valuable insight to educators and marketers to reach consumers prior to, and during, drought. Reaching individuals in a timely manner is particularly important for plant producers and retailers who desire to merchandise more drought-tolerant plants and water-saving practices to their clientele.

2.1.1 Drought Influences

There is research reported in the literature that provides a basis for understanding how consumers view water conservation, especially related to their landscape. However, the evidence is limited to a few drought-prone states. Little is known about consumer behavior during real and perceived periods of drought, especially with respect to plant production water source and water use in the landscape.

Attitude and behavioral studies have documented drought water usage for different regions of the U.S. Boyer et al. (2015) found that when California households experienced drought conditions locally, outdoor water usage did not change substantially but indoor water usage did. Fan et al. (2017) showed that Las Vegas, NV homeowners behaved similarly by landscaping homes to look more like their neighbors, which created community amenities, cultural values, and a sense of place. Homeowners that gain personal satisfaction from lawn aesthetics (often to impress neighbors) tend to irrigate more frequently (Fan et al., 2017). Incorporation of drought-tolerant plants into the landscape has been identified as a promising strategy to mitigate regional water constraints, but this will require attitudinal and behavioral changes within the communities (Fan et al., 2017).

Fan et al. (2017) discovered that a majority (77%) of homeowner respondents were more concerned with long-term droughts (or dry periods) than frequent heavy rains. Household water consumption did change under different precipitation conditions, which demonstrated that some homeowners were aware of their changing drought conditions (Gregory and Leo, 2003). This was explained as 'personal involvement', with an awareness of drought conditions leading to altered behavior (Espey et al., 1997). Awareness of local environmental issues increased the perception of personal involvement resulting in altered habits and lower water consumption rates (Gregory and Leo, 2003). Consumers' attitudes and water use during non-drought conditions can be key indicators of garden water use and plant maintenance (Syme et al., 2004). Two groups in that study, the Committed and Mainstream Environmentalists, tended to have smaller household sizes as compared to Occasional or Non-environmentalists. Non-environmentalists had a lower mean household income as compared to the other three groups. Non-environmentalists were less likely to believe helping the environment was socially acceptable and desirable (Gilg and Barr, 2006). This was correlated with their water usage and conservation practices.

2.1.2 Residential Water Use

Hayden et al. (2015) reported that as much as 70% of urban water is used to for maintaining landscape plantings. Though the reasons are various and unclear, water use appears to be important because of aesthetic and recreational priorities which are deeply ingrained in all lifestyles (Beal et al., 2013; Fan et al., 2017; Gregory and Leo, 2003; Springer, 2011; Syme et al., 2004). Water fills a basic physiological need for plants, and the plants then fill a psychological need for homeowner identity, status, and symbolic social competition (Seyranian et al., 2015). Homeowners who perceive that their landscape affects the resale value of their home tended to use more water annually, as did persons who spent more time outdoors (Syme et al., 2004). Shade trees in urban areas can offset heat for an average of 3.6 kWh/day, or approximately 30% energy savings per day (Akbari, 2005). Maintaining lush landscapes has also been heavily linked to environmental benefits such as improved air quality, rainfall runoff and flooding levels, and noise reduction (Nowak and Dwyer, 2007).

In residential settings, indoor water usage remains relatively stable throughout the year and is largely correlated to household size and appliance efficiency (Gregory and Leo, 2003; Syme et al., 2004). In fact, residential areas account for approximately 50% of urban water usage (Hayden et al., 2015). Outdoor water use is most often determined by garden type, importance and size, and social norms. Watering gardens, lawns, and landscapes is considered to be a discretionary use as compared to indoor water use, and conspicuous outdoor water use is often a prime target for regulation (Jorgensen et al., 2009). Homeowners frequently irrigate more than what is essential for their landscape because they lack knowledge about irrigation requirements (Hayden et al., 2015).

From 2001 to 2011, consumers' attitudes towards water conservation have become more positive, and this change in attitudes is followed somewhat by behavioral shifts in water usage (Beal et al., 2013). Despite the change in attitudes, a Gallup poll showed that only 5% of respondents said water conservation has become a part of a lifestyle change (shopping and living habits) to protect the environment (Gallup and Jones, 2008). Beal et al. (2013) examined perceived water usage as compared to actual water usage. Households that were informed about their areas of water usage were more accurate in evaluating water usage in their household, as compared to households who had little knowledge about their water usage and assumed their usage level. When given information about their actual water usage, households with inaccurate water assumptions made changes to their future water usage (Seyarian et al., 2015).

Throughout the U.S., water-intensive landscapes are beginning to be replaced by water-efficient and climate-appropriate landscapes (Hurd, 2006). Changing water use behavior involves several social and economic factors. For example, water preferences are not only a function of water prices and conservation motives, but also time constraints, knowledge on how to conserve, and monetary restrictions. Attempting to change preferences may produce longer-term responses for landscape water use that will reduce future water demand (Hurd, 2006).

Gilg and Barr (2006) found that many homeowners perceive their gardens require at least a minimum amount of water for plants to survive the summer. In their Australian study conducted to determine attitudes about conservation and water consumption, 25% of homeowner respondents reported watering their gardens three to four times weekly and even disregarded permitted levels of watering. At the same time, another 24% of homeowner respondents reported never watering their gardens but relied on rainfall. Outdoor water usage was observed by apartment dwellers to decrease, where 36% said the gardens around their buildings were never watered (Randolph and Troy, 2008). The most common practices made by homeowners to conserve residential water use were reducing garden watering and taking shorter showers (Randolph and Troy, 2008).

2.1.3 Demographic Characteristics and Water Use

Demographic characteristics also influence water usage and conservation. Low water users were older, less educated, and had lower incomes compared to high water users (Beal et al., 2013). Gilg and Barr (2015) also found that individuals that were considered non-environmentalists tended to be male, younger, lower income, less formal education, and less involved in the community. Increasing income level was directly related to an increase in water consumption (Mini et al., 2014; Renwick and Archibald, 1998). Households with a yearly income > $100,000 practiced water conservation more frequently and were more likely to include drought-tolerant plants into their landscape, indicating an income tipping point (Fan et al. (2017). This was also substantiated by Helfand et al. (2006), Loss et al. (2009), and Worthington and Hoffman (2006), who found that more affluent consumers were more willing to pay for eco-friendly landscape plants. Boyer et al. (2015) even found higher income households (>$75,000) were more likely to adopt indoor and outdoor water conservation practices than lower income households (<$40,000).

Being female is also positively correlated with the adoption of drought-tolerant plants and more favorable attitudes towards water conservation and environmentalism (Fan et al., 2017; Gilg and Barr, 2006). In fact, male head-of-households were 20% less likely to adopt drought-tolerant plants (Fan et al., 2017).

While age is an indicator of conservation behavior, increased knowledge and education seem to be more directly linked to adoption strategies (Gilg and Barr, 2006; St. Hilaire et al., 2010). Households with lower water use had a greater sense of conservation issues, local concerns, and future preservation of water resources (Gregory and Leo, 2003). Based on the literature, we hypothesized that (H1) not all consumers perceive drought accurately, (H2) some consumers will reduce or eliminate landscape purchases during periods of drought, and (H3) consumer perceptions about drought differ with regard to their drought status. Data to support or refute these hypotheses will have important consequences for the horticulture industry. Findings could inform educational extension and undergraduate programs, nursery producers in production decisions, and marketing strategies used by retailers. The findings could also bolster marketing efforts to encourage sustainable planting of lower water use cultivars around country during low water availability conditions. Our goal was to better understand consumer attitudes and behavior during real and perceived drought, especially in terms of their landscape purchases and gardening/landscaping activities in different regions of the U.S.

2.2 Materials and Methods

We developed an online survey instrument following widely cited market research protocols to ensure greater degree of accuracy and speed, while reducing human error and survey expenses (Cobanoglu et al., 2001; Dillman et al., 2009; McCullough, 1998). The instrument included questions regarding a wide variety of topics related to plant and water use including plant purchases and expenditures, attitudes about water conservation and landscape plants, knowledge about water conservation and landscape plants, and demographic characteristics. The content and formatting of the survey questions were adapted from Behe et al. (2013), Behe et al. (2015), and Syme et al. (2004). The protocol and instrument were approved by the university committee on research involving human subjects (Michigan State University IRB# x16-1053e Category: Exempt 2).

[The data to be used in this study was not collected from Texas A&M University but was exclusively collected through Michigan State University under IRB# x16-1053e Category: Exempt 2 before the student's dissertation program began. The student did not craft the survey, was not part of the grant, and had no interaction with research subjects or access to identifiable data. The student will only analyze de-identified data.]

We will use SPSS version 24 and SAS version 9.4 to make a series of F-test comparisons for the percent of subjects with landscape space available and irrigation areas, and percentage of plant purchases for each of the four groups identified. We will also employ a one-way ANOVA in SAS version 9.4 to make comparisons of demographic characteristics.

The use of online surveys can have disadvantages, especially if the sampling database is comprised of the same panelist under different accounts. To alleviate this concern, the researchers contracted with a company, Lightspeed Global Marketing Insite (Warren, NJ), which maintains a panel of about 1.3 million persons and has control mechanisms in place to eliminate duplicate panelists. They identified a random sample of individuals ≥ 18 years of age and distributed invitations. The survey was administered from 7 to 13 Sept. 2016, to 5,769 potential participants. Subjects were directed to answer four quality assurance checkpoints in a specific manner. This was to ensure that respondents were carefully reading every question. Our goal was to obtain at least 100 responses for one chronic drought state (California) and one non-drought state (Wisconsin) and the remaining responses from the other U.S. states.

We define areas of drought using data from the National Drought Mitigation Center (Heim, 1999). This metric is used to classify levels of drought experienced at any given time across the contiguous U.S. The U.S. Drought Monitor Drought Conditions maps for 20 Sept. 2016 and 15 Sept. 2015 were chosen due to consumer's likelihood of awareness of current drought conditions when the survey was administered (Sept. 2016) and from the previous year (Sept. 2015).

We will classify subjects into one of four groups to analyze how real and perceived drought affected attitudes and behavior related to plant purchases and water usage. We will use the question, "Were you in an area that experienced drought this year?" to assess their perception of drought. Then, we will compare their response to the drought monitor classifications to assess whether they correctly perceive being (or not being) in drought and then classify them into one of four categories: "Perceived/Real" include respondents who correctly perceive a drought when they actually experience real drought conditions (P/R); the second category is "Not Perceived/Real" for subjects who do not perceive drought conditions but actually experience them (NP/R); the third category is described as "Perceived/Not Real" for subjects who perceive a drought when their area actually do experience a drought (P/NR); and the fourth category is identified as "Not Perceived/Not Real" for subjects who do not perceive a drought nor experienced one (NP/NR).

We hypothesize that consumers are heterogeneous in their attitudes and behavior regarding plants and water conservation, depending on their real and perceived drought situations, and that their attitudes affect their behavior regarding plant purchases. For example, subjects classified in the P/R category may show a different attitude about water conservation and behavior, especially compared to subjects in NP/NR category who may not be as concerned about water use. Individuals in the NP/NR category would be described as "in normal conditions". Respondents in the P/NR category may show similar attitudes and behavior to the individuals in the P/R since they perceived a drought, even though they really are not experiencing one. The NP/R respondents are of interest since those respondents' lack knowledge about the real drought occurring in their area and could be using water excessively. We hypothesize that subjects classified as NP/NR are different demographically, spend more on plants (because they may not have known they faced water restrictions), and engage in less water conservation behavior compared to other groups. This can result from P/R subjects having concerns in the first seasons to get landscape plants established.

2.3 Results and Discussion

Completed surveys that passed the four quality assurance checks totaled 1,543 or approximately 26.7% of the recruited subjects. All U.S. states were represented except Hawaii. The mean age of respondents was 40 years old (±16.87) and predominately female

(57.8%). Mean household size was 1.2 adults and 0.43 children. Respondents were primarily Caucasian (87%), followed by African American (3%), Hispanic (3%), Asian (2.7%), and Native American, Pacific Islander, and other races (2%). Approximately a third (28.3%) earned a 4-year college degree followed by 21% of respondents who had completed some college. Less than 1.2% had a high school diploma or less. The majority of the respondents (59.8 %) lived in residential neighborhoods and their mean 2016 household income was $60,000 to $79,999. All states except for Hawaii were represented (incidental to data collection). We strived to include at least 100 respondents from chronic drought areas such as California and at least 100 respondents from non-drought states such as Wisconsin in the sample.

As compared to the 2016 U.S. Population Census (U.S. Census Bureau, 2016) from 2010 to 2015, our survey respondents represent a similar distribution. Census data indicate that the mean household income was $79,263. Total U.S. population was approximately 323 million with 125.82 million households with an average household size of 2.6 people. Racially, the population was 77% Caucasian, 13.3% African American, 17.6% Hispanic, 5.6% Asian, and 1.4% Native American, Pacific Islander, or other races. Nationally, 29.8% of Americans had a bachelor's degree or more education. Females represented 50.8% of the population and the median age was 37.9 years old (U.S. Census Bureau, 2017).

Butterfield and Baldwin (2015) reported that the average home spent $401 on lawn and garden, up from $317 in 2014. The largest segment Butterfield and Baldwin (2015) identified, Food Gardening, captured 36% of the consumer expenditures, followed by flower garden purchases at 34%. The largest portion of the 90 million households (75% of total U.S. households) who participated in lawn and garden activities had an income of

$75,000 or over, were mostly female, aged 55 years old and over, and had earned a bachelor's degree. Nearly one-third (28%) of households purchased their plants from home centers while 29% bought plants from mass-merchandisers (Butterfield and Baldwin, 2015). Without variances, it is not possible to compare the current sample with the Census and National Gardening Association (Butterfield and Baldwin, 2015) samples, but they appear to be similar in respect to variables normally affecting final demand (e.g. age, incomes, etc.).

We conducted a Chi-square test to examine the percentage of subjects whose drought conditions changed from 2015 to 2016. We found that < 3% experienced a change ($p < 0.0001$), indicating that the majority of subjects experienced a similar drought situation based on real drought condition changes from 2015 to 2016. Of the total useful responses, 16.4% were in the group P/R (correctly perceiving they were in a drought situation), 29.1% were in the group NP/NR (correctly perceiving they were not in drought), 52.3% were classified in the group NP/R (incorrectly perceiving they were not in drought), and only 2.0% were in the P/NR group (incorrectly perceiving they were in drought). Since the NP/NR were accurate in their perception that they did not experience a drought, this group may serve as a "control" or "benchmark" against which to compare the other groups. Those in the P/R were accurate in that they perceived a drought when they were really in a drought situation. But their attitudes and behavior are different from the NP/NR group who were also correct in their perceptions. Given the small number of respondents in P/NR group, they were excluded from this part of the analysis. The P/NR group actively participated in water conserving behaviors when they would not have needed to. They were removed because they represented such a small portion of the sample the NP/R group represented an interesting subset of the sample frame in that they were in a drought situation but did not perceive it. We hypothesized that their purchasing behaviors and attitudes might differ from the other two groups (P/R and NP/NR).

Demographically, the three groups were similar on five of the seven characteristics (Table 2.1). A balance test was conducted and is included in Table 2.2. Age and ethnicity were unbalanced within the sample. Subjects in NP/NR were nearly three years older than those in the NP/R group, but similar to subjects in the P/R drought area. There were no differences among the respondents in terms of gender, income, and the number of adults/children in the household. There was a difference, however, in their plant-related expenditures. Subjects in P/R spent \$24.18 less (~ 18%) on plants and related supplies in 2015 compared to expenditures for those in NP/NR group. These differences were consistent with prior work (Gilg and Barr, 2006; St. Hilaire et al., 2010).

Participants in all three groups had a similar percentage of individuals with a lawn and landscape, and patio/porch area, as well as those who had neither (only 7% overall) (Table 2.3). However, a higher percentage of participants in the P/R category irrigated turfgrass or irrigated landscape beds. Those who irrigated turfgrass areas ranged from 13.0% for the NP/NR respondents to 35.2% for the P/R group. Those who irrigated landscape beds ranged from 11.8% for NP/NR respondents to 34.7% for P/R respondents. The higher level of irrigation for the P/R group compared to the NP/NR group may reflect the possibility that the P/R group would not otherwise have turfgrass or landscape plants if they did not irrigate them. This would be consistent with the finding that a higher percentage of the NP/R group irrigated turfgrass and landscape beds more compared to the NP/NR group.

We asked what types of plants were purchased in 2016 (Table 2.4) and found that annuals were the dominant plant category purchased (by 49.8% of the respondents overall), followed by vegetables (41.6%), herbs (30.5%), perennials (29.7%), and flowering shrubs (19.2%), respectively. A much smaller percentage of subjects in each category had purchased evergreen shrubs (7.4% overall), fruit trees (9.3%), evergreen trees (6.8%), and shade trees (7.5%). Very few differences between the groups were observed, with each of the 3 groups exhibiting similar percentages of purchases for annuals, perennials, flowering shrubs, and fruit trees. However, a higher percentage of the P/R group purchased evergreen trees and shrubs compared to the other two groups. The higher incidence of purchase for evergreen shrubs and trees for those who correctly perceived drought during real drought conditions may partly be explained in that the evergreens may require less water to establish after transplanting.

Attitudinally, we found differences between the three groups (Table 2.5). When asked whether they thought water conservation was important, all three groups had a high mean score, indicating their agreement with the statements and a general importance about water conservation. However, we found a higher level of agreement, generally, in the NP/NR. This mean level of agreement was higher compared to both P/R and NP/R. A similar pattern was found when asked if water conservation was of great concern. When asked if they "know a lot about water conservation" and if they "conserved water in and around their home," there were differences among all three groups with the P/R group ranking the lowest, interestingly. Both the P/R and NP/R groups were lower than the NP/NR group for three of the attitudinal questions including "I use fixtures that help me conserve water at home," "The price of water restricts what I can do in the landscape areas outside my home," and "I have decreased my outdoor plant purchases due to water restrictions in my neighborhood." The only question in which there were no differences stating "In a water crisis, we should not buy or try to maintain outdoor landscape plants" with all three groups moderately agreeing with this statement.

This difference in attitude observed among the groups may be partly explained by the Hierarchy of Competency (Adams, 2017). Though we expected P/R to be most sensitive to drought conditions, this would not necessarily be true by the "order of recognition." Individuals begin as unconsciously incompetent and are initially unaware of what they do not know. The theory then posits that they gradually recognize they have a knowledge deficit, to knowing how to handle the knowledge deficiency. They may further develop to unconscious competency where the "skill" or knowledge is second nature. What we conclude from these results is that subjects in the P/R group likely demonstrate the consciously competent by being aware of the drought and having knowledge to adjust their lifestyles or being aware of their lack of knowledge or ability adjust to drought conditions. NP/R may demonstrate unconsciously incompetent, where they do not know the deficit of knowledge they lack and therefore are not sensitive to drought information and issues. Finally, NP/NR may demonstrate being consciously competent of their drought conditions. They recognize their drought status, but it is also possible that they have experience in drought conditions or have prior knowledge and are sensitive to drought information and issues.

These attitudinal findings support those of Beal et al. (2013) regarding the degree to which social awareness and exposure to drought conditions affect attitudes towards water conservation. We speculate that maybe the more a person becomes aware of a drought the more they may realize they do not know. Beal et al. (2013) observed when people who are over or under-estimating their water usage are made aware of their actual water usage (education/awareness) they could change their habits. But technology engineered to assist with water conservation needed to be tied to water conserving behavior – not used as a crutch. There is a paradox in which the more underestimating water consumers are made aware of their behavior, the more they realize they do not know.

2.4 Conclusion

Given the increasing importance of water-related issues across the U.S., it is imperative to increase our understanding of how consumers view water conservation, especially related to the lawns and landscapes surrounding their homes. However, the evidence to date in the literature has been limited to a few states. In addition, we know relatively little about consumer behavior during real and perceived periods of drought, especially with respect to landscape plant purchases. As importantly, we do not know for sure if consumers perceive drought periods correctly, let alone whether they are likely to modify their landscape care and maintenance practices during periods of drought or if a drought influences their plant purchasing decisions at all. This study was developed to explore the answers to these questions, which will have important implications for the horticulture industry.

Our goal was to better understand consumer behavior during real and perceived drought situations, especially in terms of their landscape purchases and gardening/landscaping activities. We hypothesized that consumers were heterogeneous in their attitudes and behavior regarding plants and water conservation, depending on their real and perceived drought situations, and that their attitudes affected their behavior regarding plant purchases. Findings from this study confirm this hypothesis. For example, subjects classified in the P/R category demonstrated a different attitude about water conservation and plant purchasing behavior, especially compared to subjects in the NP/NR category. More education is still needed to help facilitate the transition from intensively managed landscapes to include the use of plants or cultivars that use less water. Growers, wholesalers, and retailers will benefit from leading some of this change by promoting the water use needs of plants, especially those with lower use, and continuing to communicate water sources in plant production as well as landscape water needs.

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Table 2.1 Mean and standard deviation of seven demographic characteristics of respondents.

Characteristic	P/R (n=252)	NP/R (n=803)	NP/NR (n=448)	Significance level
Age	57.46 (15.39) ab	55.87 (17.25) b	58.73 (16.68) a	0.014
% Female	57 (0.49)	58 (0.49)	57 (0.49)	0.996
Adults in household	1.08 (0.88)	1.21 (0.902)	1.19 (0.88)	0.158
Children in household	0.38 (0.80)	0.45 (0.90)	0.41 (0.85)	0.490
Income	$64,007 ($47,824)	$67,828 ($45,452)	$69,235 ($47,887)	0.373
Plant related expenditures 2015	$107.78 (($125.06) a	$120.88 ($133.44) ab	$131.96 ($146.42) b	0.077
Plant related expenditures 2016	$105.28 ($124.70)	$117.80 ($132.06)	$127.08 ($135.91)	0.112

Note: Responses were to a water-related survey of households in 2016 that were in a real drought situation and correctly perceived it (P/R); in a real drought situation but did not perceive it (NP/R); and not in a real drought situation and did not perceive it (NP/NR). Statistically significant coefficients (P values < 0.10) are presented in bold. Different letters within rows indicate statistically significant differences. Analyses were generated using the GLIMMIX procedure of SAS software (SAS for Windows, v 9.4, SAS Institute Inc.).

Table 2.2 Balancing test of the four types of subjects based on real drought status and perceived drought status.

Characteristic	F	Significance level
Gender	0.76	0.5145
Age	**3.60**	**0.0130**
Education	1.84	0.1377
Income	0.94	0.4201
Ethnicity	**4.54**	**0.0036**
# of Adults in Household	2.14	0.0928
# of Children in Household	1.52	0.2071
Spending in 2016	1.73	0.1586
N	122	

Note: Using one-way ANOVA; values bolded if significant at $P \leq 0.05$.

Table 2.3 F-test comparison of percent of subjects with landscape space available and irrigation areas of respondents.

	Total (n=1467)	P/R (n=252)	NP/R (n=803)	NP/NR (n=448)	Significance level
Space Available					
Lawn and Landscape	77.8	77.1	78.0	78.6	0.374
Patio Porch	15.2	17.4	14.6	13.3	0.281
Neither	7.0	5.5	7.4	8.1	0.340
Irrigate turfgrass	27.0	35.2a	27.2b	13.0c	0.001
Irrigate landscape beds	25.0	34.7a	23.8b	11.8c	0.001

Note: Responses were to a water-related survey of households in 2016 that were in a real drought situation and correctly perceived it (P/R); in a real drought situation but did not perceive it (NP/R); and not in a real drought situation and did not perceive it (NP/NR). Statistically significant coefficients (P values < 0.01) are presented in bold. Different letters within rows indicate statistically significant differences. Analyses were generated using the GLIMMIX procedure of SAS software (SAS for Windows, v 9.4, SAS Institute Inc.).

Table 2.4 F-test comparison of percentage of plant purchases of respondents to a water-related survey of households in 2016.

Plant Type	Total	P/R	NP/R	NP/NR	Significance level
Annual	49.9	49.4	49.7	51.2	0.897
Vegetable	41.4	41.7	40.0	45.2	0.356
Herb	30.3	30.9	31.3	25.8	0.244
Perennial	29.9	29.8	29.4	31.4	0.828
Flowering shrub	19.2	18.5	19.6	19.0	0.905
Evergreen shrub	7.4	9.8 a	6.5 b	6.0 ab	0.073
Fruit tree	9.3	9.2	9.4	8.9	0.957
Evergreen tree	6.9	8.2 a	7.2 ab	3.6 b	0.074
Shade tree	7.6	9.6	6.7	6.8	0.158

Note: Categories were in a real drought situation and correctly perceived it (P/R); in a real drought situation but did not perceive it (NP/R); and not in a real drought situation and did not perceive it (NP/NR). Statistically significant coefficients (P values < 0.10) are presented in bold and different letters within rows indicate statistically significant differences. Analyses were generated using the GLIMMIX procedure of SAS software (SAS for Windows, v 9.4, SAS Institute Inc.).

Table 2.5 Mean and standard deviation for attitudinal measures of respondents to a water-related survey of households in 2016.

	P/R (n=252)	NP/R (n=803)	NP/NR (n=449)	Significance level
I think that WC is important.	4.37 (0.832) b	4.45 (0.769) b	4.66 (0.615) a	0.000
I think that WC is of great concern to me.	4.03 (0.944) a	4.15 (0.886) ab	4.36 (0.615) b	0.000
I know a lot about WC.	2.70 (1.062) c	2.90 (1.064) b	3.07 (1.028) a	0.000
I conserve water in and around my home.	3.47 (1.116) c	3.67 (1.020)b	3.93 (0.913) a	0.000
I use fixtures that help me conserve water at home.	3.15 (1.197) b	3.27 (1.157) b	3.50 (1.117) a	0.000
The price of water restricts what I can do in the landscape areas outside my home.	2.42 (1.236) b	2.53 (1.279) b	2.88 (1.355) a	0.000
In a water crisis, we should not buy or try to maintain outdoor landscape plants.	3.19 (0.927)	3.16 (0.986)	3.27 (1.011)	0.200
I have decreased my outdoor plant purchases due to water restrictions in my neighborhood	2.01 (1.004) b	2.17 (1.044) b	2.59 (1.220) a	0.000

Note: Statistically significant coefficients (P values < 0.01) are presented in bold. Different letters within rows indicate statistically significant differences. Analyses were generated using the GLIMMIX procedure of SAS software (SAS for Windows, v 9.4, SAS Institute Inc.). Categories were in a real drought situation and correctly perceived it (P/R); in a real drought situation but did not perceive it (NP/R); and not in a real drought situation and did not perceive it (NP/NR). Mean scores are based on a 5-point Likert scale where 0 = strongly disagree and 5 = strongly agree. WC=water conservation.

3. CONSUMER PERCEPTIONS OF LANDSCAPE PLANT PRODUCTION WATER SOURCES AND USES IN THE LANDSCAPE DURING PERCEIVED AND REAL DROUGHT*

Water is becoming scarcer as world population increases and will be allocated among competing uses. Some of that water will go toward sustaining human life, but some will be needed to install and support landscape plants. Thus, future water resource availability may literally change the American landscape. Recent research suggests that consumers' attitudes and behaviors toward potable water supplies have changed in other countries because of greater social awareness and increasingly widespread exposure to drought conditions. Using the same survey as in Chapter 2, consumers were asked to assess their perceptions about landscape plants, the water sources used to produce them, and plant water needs to become established in the landscape. Using two separate conjoint designs, we will assess their perceptions of both herbaceous and woody perennials.

3.1 Literature Review

Water is essential for life, including plant life, and water resources are likely to become scarcer as the world population increases (Springer, 2011). Some of that water will be needed to install and support landscape plants and future water shortages may literally change the American landscape if enough water is not allocated to ensure plant survival. This change may be in regionally native plants or overall drought tolerant species.

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*Reprinted with permission from "Consumer Involvement with and Expertise in Water Conservation and Plants Affect Landscape Plant Purchases, Importance, and Enjoyment" by Knuth, M., Behe, B.K., Hall, C. R., Huddleston, P. T., & Fernandez, R., 2018. HortScience 28(1), 85-93, Copyright [2018] by American Society of Horticultural Sciences.

Recent research suggests consumers' attitudes and behavior towards potable water supplies have changed in other countries, in particular Australia, due to greater social awareness and increasingly widespread exposure to drought conditions (Beal et al., 2013). Changing water use behavior involves a number of social and economic factors (Hurd, 2006, Syme et al., 1991). Outdoor water use preferences are not only influenced by water prices and conservation motives, but also the time needed to implement conservation activities, knowledge on how to conserve water, and monetary restrictions. Influencing consumer attitudes, in turn, results in longer-term responses for landscape water use thereby potentially reducing future water demand (Hurd, 2006).

3.1.1 Consumer Attitudes in Water Use and 'Pro-Environmental' Behavior

Consumers' attitudes regarding water conservation have become more positive and this change in attitudes is paralleled by small behavioral shifts in water usage (Beal et al., 2013). When given information about their water usage, households with inaccurate water assumptions made changes to their future water usage (Seyarian et al., 2015). Results from Seyranian et al. (2015) found that 84% of households who received feedback on their water consumption and potential reduction methods reduced their total water consumption. Beal et al. (2013) examined perceived water usage as compared to actual water usage. Households that were informed about their water usage were more accurate in evaluating their water usage in their household. Other recent work suggests that consumers are more willing to purchase and pay more for plants grown using more environmentally friendly practices (Behe et al., 2013; Hall et al., 2010).

St. Hilaire et al. (2010) discovered landscape water use could be significantly reduced in NM communities when homeowners feared an imminent water shortage. They also found that educational programs regarding public water conservation influenced landscape choices from existing landscape plants to planting more water conserving landscape plants. It would be noteworthy to understand how pervasive this perception is across the U.S.

The findings of these studies suggest people have a disinclination to engage in pro-environmental behaviors if they have a knowledge deficit. In other words, expertise about water consumptions matters. The key factor to explain this behavior is whether water knowledge includes actual water saving skills.

3.1.2 Irrigation and Water Usage in the Landscape

In the residential context, indoor water usage remains relatively stable throughout the year and is largely attributed to household size and appliance efficiency (Gregory and Leo, 2003; Syme et al., 1991). However, outdoor water use is most often determined by seasonal need, garden type and importance, social norms, and size.

Caring for maintaining landscapes can have potential benefits to homeowners. Intensively cultivated landscapes meet aesthetic and recreational priorities of homeowners, which are deeply ingrained in all lifestyles regardless of social status (Beal et al. 2013; Fan et al., 2017; Gregory and Leo, 2003; Springer, 2011; Syme et al., 2004). Plants in intensively managed landscapes fill a psychological need for homeowners, affecting their identity, status, and symbolic social competition in their respective communities (Seyranian et al., 2015). Homeowners who considered their gardens as positive influences on the resale value of their house used more water annually, as did persons who spent more time outdoors (Syme et al., 2004). Increased knowledge and education seem to be directly linked to conservation adoption strategies such as turning off the tap when washing dishes or buying plants that need less water (Gilg and Barr, 2006; St. Hilaire et al., 2010). Householders using less water had a greater concern for conservation issues, local concerns and future preservation of water resources (Gregory and Leo, 2003).

Higher water usage is associated with lifestyle preferences for large gardens, large lawns, lush/vegetative home environments, and high enjoyment of gardening. Jorgenson (2009) and Syme et al. (2004) both found that garden recreation, garden value, how much people spend on their gardens, and attitudes towards the price of water all affect water usage behavior. Hayden et al. (2015) reported when given the choice between three different landscapes ranked as high managed (A), moderately managed (B), and low managed (C), landscape B was most aesthetically preferred, while landscape C was found to be the "most ecologically/environmentally friendly". In this context, the term "managed" means the level of input, resources, and time required to maintain the landscape. Hayden et al. (2015) also observed 50% of respondents did not find a time-intensive landscape to be unappealing because they enjoyed gardening and yard work. Though 82% of respondents recognized the highly managed landscape (A) required the most water to maintain and the low managed landscape (C) required the least, this still did not persuade respondents to select the low managed landscape (C) as most preferred when only considering water use. This may indicate a barrier in knowledge and potential deterrent behavior in homeowners, presenting a much-needed educational opportunity.

The use of water-conserving plants and suitable eco-friendly plants has been promoted as a water conservation strategy for homeowners. A better understanding of consumer perceptions of water source and landscape plant water use would help plant sellers and policy makers know what consumers are currently thinking and what motivates their water use behavior before additional reductions in water use change the industry in unintended ways.

3.1.3 Water Sources

Recycled wastewater, from washing machines, bathtubs, showers and sinks but not toilets, constitutes approximately 60% of the total wastewater from households. This can equate to about 30,000 gal of greywater a year for a family of four (Al-Jayyousi, 2003; Cabrera et al., 2013). Potentially, if greywater is treated correctly, or is used on a suitable plant community to accommodate [compounds] present, it can result in groundwater recharge, and may play a substantial role in the reuse and total reduction of water usage by households (Al-Jayyousi, 2003; Eriksson et al., 2002). Not much data is available regarding U.S. recycled water usage, but California's Department of Water Resources released a short report, Water Facts No. 23, reporting the usage of recycled water during the year 2002. Approximately 525,000 acre-feet of recycled water was reused in California (1 acre-foot is equal to 326,000 gal). Agricultural irrigation used approximately 46% of the total recycled water available annually, followed by landscape irrigation (21%), and, lastly, groundwater recharge (14%) (California Department of Water Resources, 2004).

However, fresh water has been traditionally used for all indoor and outdoor purposes because of the lack of information and fear of detrimental contaminants from recycled water (St. Hilaire et al., 2008). St. Hilaire et al. (2008) stated, "[the] possible risks include human health-related problems, soil salinization and plant damage, leached nutrients as environmental contaminants, and the loss in aesthetic value of water features" if humans come into direct contact with graywater. Thus, Municipalities in Orange County, California require irrigation with graywater to occur at night to minimize human exposure

(Western Municipal Water District, 2017). In contrast to Yanko (1992) could not find any detectable hazards associated with reused water when used to irrigate parks, urban landscapes, agricultural crops or groundwater recharge in California.

Research has not documented the overall perception of water sources and uses by plants in the landscape throughout the U.S. For example, attitudes and behaviors in areas prone to drought situations may be different from areas with sporadic or no drought conditions. In turn, the attitudes and behaviors of consumers will likely influence their plant purchases and the maintenance of plants already in their landscape. Palma et al. (2016) used a Discrete Choice experiment to show that water conservation efforts in the landscape were more important to subjects than water conservation in production. To investigation this further, with the addition of irrigation needs as well, our objective was to assess the attitudes and behaviors of a large sample of US consumers to better inform Green Industry firms about potential future consequences to the industry. More specifically, we sought to identify consumer preferences for the water source and amount used during the production of plants versus their water use in the landscape. Furthermore, we wanted to assess the impact of real and perceived drought on the attitudes and behavior of consumers.

3.2 Materials and Methods

Consumers buy products they value, and researchers usually estimate this value based on attributes that comprise the product. Conjoint analysis is one mechanism that allows researchers to estimate how consumers value each attribute. It is a widely used method to characterize consumer preferences and the relative importance of product attributes. Conjoint analysis has been used to understand the consumers' purchase drivers and willingness to pay for attributes and attribute levels for a wide range of horticultural products, including Christmas trees (Behe et al., 2005b), landscapes (Behe et al., 2005a), biodegradable pots (Yue et al., 2010), mixed flowering annual containers (Mason et al., 2008), impatiens alternatives (Getter and Behe, 2013), sustainable/eco-friendly plant production (Behe et al., 2010, 2013; Rihn et al., 2015, 2016), and vegetable and herb plant brands (Behe et al., 2016). By assessing consumer's valuation on each product attribute, we can determine the related level of part-worth utility associated with each attribute, as well as the product as a whole.

Using the same survey as in Chapter 2, we developed two separate conjoint designs: one for woody perennials and one for herbaceous perennials. We employed a combination of product attributes and levels that represented three plant types (genus), three price levels, three water sources during production (grown in the nursery with fresh water, grown in the nursery with recycled water, grown in the nursery with a blend of fresh and recycled water), and two landscape water use levels (requires irrigation in the landscape, but only for the first season to help the plant to become established; requires irrigation in the landscape for most seasons after establishment) for a 3 x 3 x 3 x 2 factorial design. The landscape water use categories were derived from the University of California-Davis Water Use Classification of Landscape Species IV (Costello and Jones, 2014). These categories were based on the rate of evapotranspiration expressed as a percentage in reference to evapotranspiration rates in maintained, well-irrigated tall fescue turf. Plants classified in the "high" category need frequent irrigation in during normal rainfall years, plants classified in the "low" category need minimal irrigation during years of normal rainfall, and plants classified in the "very low" category need no irrigation except during years below average rainfall (Costello and Jones, 2014). However, all six plants used in this study appear on the list for low water use plants. The herbaceous perennial plants included were coral bells (Heuchera americana), English lavender ((Lavendula angustifolia 'Munstead'), and perennial verbena (Verbena 'Homestead Purple') with prices of $6.99, $9.99, and $12.99 per container. The woody perennials included were goldenrain tree (Koelreuteria paniculata), fragrant sumac (Rhus aromatica 'Gro Low'), and redbud (Cercis canadensis) with prices of $19.99, $29.99 and $39.99 per container. Price points were established through conversations with industry practitioners. Although all 54 combinations could have been presented to subjects, we developed two fractional factorial designs of 9 combinations using SPSS software (version 22, version 22; IBM, Armonk, NY)). This was done to retain the ability to assess all attributes in the complete design but reduce the time required and, the resulting potential, for subject fatigue (Chrzan and Orme, 2000). Each digital image consisted of a picture of the plant in a container photographed against a black background with the accompanying information above the image (Fig. 3.1).

The survey was comprised of five parts: 1) types and amounts of plants purchased; 2) conjoint questions for both herbaceous perennials and woody perennials; 3) water conservation knowledge and behavior; 4) plant knowledge and 5) demographic characteristics. In this chapter, we analyzed only the data for the conjoint studies and demographic characteristics.

In order to compare respondents in different water/drought situations, we used the four categories based on whether they accurately perceived if the region in which they lived was experiencing drought as defined by Knuth et al., (2018). The four categories are based on whether they accurately perceived if the region in which they lived was experiencing drought. The four categories of drought perception were Not Perceived/In Real Drought (NP/R), Not Perceived/Not in Real Drought (NP/NR), Perceived/In Real Drought (P/R), and Perceived/Not in Real Drought (P/NR). Attitudes and behaviors for those who correctly perceived they were in drought were different from those who correctly perceived they were not in drought, as well as those who incorrectly did not perceive they were in an actual drought. We compared those groups on their responses to the conjoint portion of the survey. We tested differences between utility and importance values with the TRANSREG and GLIMMIX procedures of SAS software (version 9.4, Cary, NC).

3.3 Results

Our sample population was comparable to the 2016 U.S. Population Census (U.S. Census Bureau, 2016), from 2010 to 2015, Americans were 37.8 years old, had a mean household income of $79,263. The total U.S. population is approximately 323,127,513. Average household size is 2.6 people. The population is 77% white, 13.3% Black/African American, 17.6% Hispanic, 5.6% Asian, and 1.4% Native American, Pacific Islander, or other races. Nationally, 29.8% of Americans have a bachelor’s degree or higher. Females represent 50.8% of the population and the median age is 37.9 years old (U.S. Census Bureau, 2016). However, without published variances, it is not possible to compare the samples statistically.

The national average of horticulture-related spending in 2015 by the households participating in the National Gardening Survey was $401, up from $317 in 2014 (Butterfield and Baldwin, 2016). The largest segment, Food Gardening, captured 36% of the consumers followed by Flower Gardens at 34%. The largest portion of the 90 million households (75% of total U.S. households) who garden, have an income of $75,000 or over, mostly female, 55 years old and over, and bachelor's degrees. 28% of households buy their plants from home centers while 29% buy from mass-merchandisers. The sample frame in our study appears to be similar to the U.S. Census and National Gardening Association samples.

Overall, 49.8% of all subjects had purchased annual plants in 2016, 42% had purchased a vegetable transplant, 30% purchased an herb, 30% had purchased a perennial, 19% had purchased a flowering shrub, 9% purchased a fruit tree, 7% had purchased an evergreen shrub or shade tree (Table 3.1). Twenty-one percent bought an indoor flowering plant. Mean plant expenditures were $122.52 in 2015 and were $119.07 in 2016 (Table 3.1). The percentage of subjects in the three categories who purchased evergreen shrubs, evergreen trees, and indoor flowering plants differed in this study. Half as many subjects in the NP/NR purchased an evergreen tree compared to those in the P/R or NP/R categories. A higher percentage of the P/R respondents purchased evergreen trees compared to respondents in the NP/R or NR/NP categories. More individuals in the NP/R and P/R group purchased indoor flowering plants compared to the other group. They also spent the more on plants and related gardening supplies, excluding equipment in 2015.

Next, we analyzed the conjoint design for perennials, both overall and by drought perception group (Table 3.2). Price and water use in the landscape were statistically similar. The perennial verbena was preferred over the English lavender and the coral bells was least preferred. Plants grown with fresh water were preferred over plants grown with recycled water and the blend of fresh and recycled water was the least preferred. In terms of water use in the landscape, respondents most preferred plants that required irrigation but only for the first season. And, following economic logic, lower prices were preferred to higher prices.

There were several differences between the drought perception/realization groups. The water use in the landscape attribute was slightly more important for the NP/NR group compared to the other two groups, both of which had experienced a real drought. In addition, the utility score for “grown in the nursery with fresh water” was lower for the NP/NR group compared to the NP/R group. We also found that the NP/NR group valued less (had a lower utility score) “requires irrigation in the landscape but only for the first season to help the plant become established” compared to the NP/R group.

For woody perennials overall, plant genus was the most important attribute, followed by price, water use in production and least important was water use in the landscape (Table 3.3). Redbud was the most preferred plant, followed by goldenrain tree and fragrant sumac. Grown with fresh water or grown with a blend of fresh and recycled water were preferred overgrown with recycled water. Requiring irrigation until establishment was preferred over requiring irrigation for most seasons. Again, following economic logic, lower prices were preferred to higher prices. In comparing between the groups, only one difference: Plant genus was more important for NP/R compared to NP/NR.

3.4 Discussion

For both herbaceous perennials and woody perennials, plant genus was the most important factor. This was consistent with much of the prior literature where the plant type was the primary factor in the decision to purchase or likelihood to buy rating (Behe et al., 2005a, 2005b, 2010, 2013, 2016; Getter and Behe, 2013; Mason et al., 2008; Rihn et al., 2015, 2016; Yue et al., 2010). The novel contribution from this study is that water source during production and water use while in the landscape were at least as important as price. This finding suggests that there may be some benefit to describing both water source and water needs for plants expected to last more than one season (e.g. herbaceous perennials and woody perennials) in point of purchase information. St. Hilaire et al. (2008) showed educational programs regarding public water conservation influenced landscape choices from present landscape plants to more water conserving landscape plants. Promotion of low water use plants as well as the use of recycled water in plant production of those plants may become marketable benefits.

Consumers placed greater relative importance on water source during production over water use in the landscape for both herbaceous and woody perennials included in this study. They preferred fresh water over recycled water and least preferred a blend of fresh with recycled water for perennials and recycled water used for woody perennials. Additionally, the NP/R group, who incorrectly assessed they were not in a drought when they actually were, placed a higher value on nursery plants grown with fresh water compared to those who were actually not in drought and did not perceive one (NP/NR, the comparison group). This finding parallels what St. Hilaire et al. (2008) found in that, despite scant evidence of the increased risk of disease, recycled water has become more popular only among water conservationists who seek to achieve more efficient ways to use water.

Hurd (2006) suggested that with a focus on consumer attitudes, changes in landscape plant selection could reduce overall water use and reduce future water demand. The attitude that recycled water was not as valuable (lower utility score), especially for the

NP/R group shows a great need for education. Consistent with St. Hilaire et al. (2008) and Yanko (1992), subjects in this study may have preferred fresh water due to concerns about or lack of information regarding the safety of recycled (greywater). Clearly, this is a point for future education, especially for nurseries striving to conserve water resources in other work has shown sustainability concerns by consumers often translate into substantial willingness to pay price premiums (Behe et al., 2010, 2013; Getter et al., 2016; Khachatryan et al., 2016). The use of biodegradable containers, for example, translates into higher price premiums for ornamental products (Yue et al., 2010). St. Hilaire et al. (2008) showed when communities favorably viewed recycled water as a valuable resource if they understood their water situation, they substantially reduced water use in NM communities. Many of our subjects appeared to be unlike those in St. Hilaire et al. (2008) in that they discounted the importance of recycled water and preferred to use fresh water. Perhaps the use of recycled water could be more socially acceptable if it were marketed as a means to produce a high-quality product while conserving an important natural resource on the farm or production site.

Plant water needs in the landscape were less important than water source for those respondents of this study. Requiring irrigation for one season for plant establishment was clearly preferred over requiring irrigation for most seasons after establishment for both herbaceous perennials and woody perennials. However, we observed some differences in drought perception/realization group for landscape water use for perennials. The comparison group NP/NR placed a higher value on the requirement for irrigation during the first season when compared to the NP/R group. These finding suggest that, with some additional education about the water use needs of landscape plants, the value for plants requiring irrigation in only the first season might be improved. Marketing the water needs of plants may become a more valuable attribute.

We found few differences between the three drought perception groups, but they appear to be important differences. Since 30% of the respondents had purchased perennials while only 7% to 9% had purchased some type of tree (e.g. evergreen, fruit, or shade), the low purchase rate of trees may be one reason for finding few differences.

3.5 Conclusion

The findings from this study, for the first time, combine different production water sources and landscape water uses and shows that water source in production and water use needs in the landscape are relatively similar to price in terms of relative importance. This is very similar results to Palma et al. (2016). This is helpful information for the Green Industry in that efforts to communicate water source and water needs may be favorably received by consumers. Hall and Dickson (2011) reported that consumers "have, however, exhibited a willingness to purchase and, in some cases, pay a premium for products and services that enhance their quality of life in terms of social well-being, physical well-being, spiritual well-being, and environmental well-being." Kotler and Keller (2016) would argue that consumers buy benefits, not product features or attributes. Plant water use and water source for production could potentially be marketed to show the consumer environmental benefits.

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Table 3.1 Overall percentage of respondents purchasing 12 plant types and amount spent on plants and related supplies (excluding equipment) in 2015 and 2016.

	Total	NP/R (%) [Mean (SE)]	NP/NR (%) [Mean (SE)]	P/R (%) [Mean (SE)]
	n=1535	n=803	n= 252	n=449
Plant type				
Annual	50	50	50	49
	(0.13)	(0.18)	(0.32)	(0.24)
Vegetable	42	40	45	42
	(0.013)	(0.017)	(0.031)	(0.023)
Herb	30	32	25	31
	(0.012)	(0.016)	(0.027)	(0.022)
Perennial	30	30	31	29
	(0.012)	(0.016)	(0.029)	(0.022)
Flowering shrub	19	20	19	19
	(0.010)	(0.014)	(0.025)	(0.019)
Evergreen shrub	8	6 a	6 a	10 b
	(0.007)	(0.009)	(0.015)	(0.014)
Fruit tree	9	9	9	10
	(0.007)	(0.010)	(0.018)	(0.014)
Evergreen tree	7	7 b	4 c	8 b
	(0.007)	(0.009)	(0.012)	(0.013)
Shade tree	8	6	7	10
	(0.007)	(0.007)	(0.016)	(0.014)
Indoor flowering plant	21	23 b	16 c	20 b
	(0.010)	(0.015)	(0.023)	(0.019)
Indoor foliage plant	11	11	11	12
	(0.008)	(0.011)	(0.310)	(0.015)
Succulent	14	14	11	16
	(0.009)	(0.012)	(0.020)	(0.017)
Amount spent on plants in 2016	$119.07	$117.80	$105.28	$127.08
	($3.40)	($4.97)	($7.88)	($6.47)
Amount spent on plants in 2015	$122.52	$120.88 b	$107.78 a	131.96 b
	($3.51)	($4.74)	($7.91)	($6.97)

Note: These comparisons are among respondents in three drought situations/perceptions (NP/R = in a real drought, but drought not perceived; NP/NR= correctly perceived no real drought; P/R= correctly perceived being in a real drought). Lower case letters indicate significant differences between rows at $P < 0.010$. Utility and Importance values, and data analyses were generated using the TRANSREG and GLIMMIX procedures of SAS software ($p \leq 0.05$).

Table 3.2 Overall herbaceous perennial conjoint analysis from a national online survey of 1,295 respondents showing relative importance and utility scores.

	Total	NP/R	NP/NR	P/R	Significance level
Herbaceous perennial plants					
	n=1295	n=675	n=208	n=377	
(Num df/Den df) F, P	(3, 5176) 623.41 <.0001	(3, 2696) 340.05 <.0001	(3, 828) 143.02 <.0001	(3, 1507) 135.28 <.0001	
Relative Importance	[Mean (SE)]	[Mean (SE)]	[Mean (SE)]	[Mean (SE)]	
Plant genus	40.778 a (0.556)	41.090 a (0.768)	39.251 a (1.047)	42.524 a (1.376)	0.04, 0.9603
Production water source	24.753 b (0.349)	24.716 b (0.487)	24.891 b (0.645)	24.604 b (0.847)	1.97, 0.1405
Water use in the landscape	17.850 c (0.435)	17.602 c AB (0.586)	19.353 c A (0.880)	16.110 c B (0.931)	3.15, 0.0431
Price	16.619 c (0.414)	16.592 c (0.581)	16.505 d (0.760)	16.762 c (1.000)	0.02, 0.9803
Utility Score					
(Num df/Den df) F, P	(10, 14234) 228.88 <.0001	(10, 7414) 117.36 <.0001	(10, 4136) 61.24 <.0001	(10, 2277) 46.32 <.0001	
coral bells	-0.373 f (0.033)	-0.378 f (0.044)	-0.349 f (0.061)	-0.374 e (0.090)	
English lavender	-0.073 d (0.033)	-0.073 de (0.046)	-0.068 de (0.059)	-0.087 cd (0.092)	
perennial verbena	0.445 a (0.029)	0.451 a (0.040)	0.417 a (0.051)	0.461 a (0.085)	
grown in the nursery with fresh water	0.201 b (0.016)	0.240 b A (0.021)	0.148 bc B (0.029)	0.169 b AB (0.040)	3.62, 0.0271
grown in the nursery with recycled water	0.054 c (0.016)	0.050 cd (0.023)	0.064 cd (0.029)	0.041 bc (0.044)	0.12, 0.8886

Table 3.2 Continued.

	Total	NP/R	NP/NR	P/R	Significance level
grown in the nursery with a blend of fresh and recycled water	-0.256 e (0.02)	-0.290 f (0.026)	-0.212 ef (0.038)	-0.210 de (0.057)	1.89, 0.1514
requires irrigation in the landscape, but only for the first season to help the plant become established.	0.207 b (0.019)	0.141 bc B (0.026)	0.311 ab A (0.039)	0.224 b AB (0.046)	7.2, 0.0008
requires irrigation in the landscape for most seasons after establishment.	-0.207 e (0.019)	-0.141 e A (0.026)	-0.311 f B (0.039)	-0.224 de AB (0.046)	7.2, 0.0008
$6.99	-0.676 g (0.036)	-0.667 g (0.05)	-0.643 g (0.068)	-0.756 f (0.082)	
$9.99	-0.966 h (0.052)	-0.953 h (0.072)	-0.919 h (0.097)	-1.081 g (0.117)	
$12.99	-1.256 i (0.067)	-1.239 i (0.094)	-1.194 i (0.126)	-1.405 h (0.152)	

Note: Comparisons were made among respondents in three drought situations/perceptions (NP/R = in a real drought, but drought not perceived; NP/NR= correctly perceived no real drought; P/R= correctly perceived being in a real drought). Utility and Importance values, and data analyses were generated using the TRANSREG and GLIMMIX procedures of SAS software (SAS for Windows, version 9.4, SAS Institute Inc., Cary, North Carolina). The abbreviation "Num df/Den df" means Numerator degrees of freedom/Denominator degrees of Freedom, "F" means F-statistic, "P means p-value. A higher utility score indicates a greater importance, or preference, for an attribute. A lower utility score indicates lack-of interest, or preference, for an attribute. Lower case letters indicate significant differences between rows at $P < 0.010$. Upper case letters indicate significant differences between columns at $P<0.010$.

Table 3.3 Overall woody perennials conjoint analysis from a national online survey of 1,241 respondents showing relative importance and utility scores.

	Total	NP/R	NP/NR	P/R	Significance level
Woody perennials					
	n=1241	n=645	n=364	n=196	
(Num df/Den df)	(3, 4960)	(3, 2576)	(3, 1452)	(3, 780)	
F,	755.97	399.85	177.52	167.05	
P	<.0001	<.0001	<.0001	<.0001	
Relative Importance	[Mean (SE)]	[Mean (SE)]	[Mean (SE)]	[Mean (SE)]	
Plant genus	45.505 a (0.680)	45.624 a AB (0.692)	43.478 a B (0.931)	49.057 a A (1.246)	3.48, 0.0311
Production water source	19.101 b (0.360)	18.750 b (0.692)	19.795 b (0.931)	18.436 b (1. 246)	1.06, 0.3479
Water use in the landscape	16.093 c (0.422)	16.072 c (0.692)	16.876 c (0.931)	15.000 b (1. 246)	1.01, 0.3640
Price	19.301 b (0.479)	19.554 b (0.692)	19.851 b (0.931)	17.507 b (1. 246)	1.37, 0.2552
Utility Score (Num df/Den df) F P	(10, 13640) 343.41 <.0001	(10, 7084) 173.5 <.0001	(10, 3993) 101.51 <.0001	(10, 2145) 59.48 <.0001	
redbud	0.801 a (0.036)	0.800 a (0.052)	0.725 a (0.066)	0.933 a (0.082)	
goldenrain tree	-0.238 e (0.029)	-0.242 de (0.041)	-0.222 ef (0.054)	-0.249 d (0.072)	
fragrant sumac	-0.563 f (0.035)	-0.559 f (0.049)	-0.504 g (0.067)	-0.684 e (0.087)	
grown in the nursery with fresh water	0.061 c (0.014)	0.053 c (0.020)	0.033 cd (0.027)	0.098 bc (0.028)	1.14, 0.3205
grown in the nursery with recycled water	-0.132 d (0.015)	-0.114 d (0.021)	-0.128 de (0.028)	-0.16 d (0.036)	0.59, 0.5570
grown in the nursery with a blend of fresh and recycled water	0.071 c (0.014)		0.095 c (0.028)	0.062 c (0.032)	0.59, 0.5539

Table 3.3 Continued.

	Total	NP/R	NP/NR	P/R	Significance level
requires irrigation in the landscape, but only for the first season to help the plant become established.	0.304 b (0.018)	0.061 c (0.019)	0.317 b (0.032)	0.303 b (0.047)	0.11, 0.8941
requires irrigation in the landscape for most seasons after establishment.	-0.304 e (0.018)	0.298 b (0.025)	-0.317 f (0.032)	-0.303 d (0.047)	0.11, 0.8941
$19.99	-0.707 g (0.033)	-0.298 e (0.025)	-0.761 h (0.064)	-0.619 e (0.075)	
$29.99	-1.079 h (0.051)	-0.698 g (0.046)	-1.162 i (0.098)	-0.944 f (0.115)	
$39.99	-1.451 i (0.068)	-1.066 h (0.070)	-1.563 j (0.131)	-1.270 g (0.155)	

Note: Comparisons were made among respondents in three drought situations/perceptions (NP/R = in a real drought, but drought not perceived; NP/NR= correctly perceived no real drought; P/R= correctly perceived being in a real drought). Utility and Importance values, and data analyses were generated using the TRANSREG and GLIMMIX procedures of SAS software (SAS for Windows, version 9.4, SAS Institute Inc., Cary, North Carolina). The abbreviation "Num df/Den df" means Numerator degrees of freedom/Denominator degrees of Freedom, "F" means F-statistic, "P" means p-value. A higher utility score indicates a greater importance, or preference, for an attribute. A lower utility score indicates lack-of interest, or preference, for an attribute. Lower case letters indicate significant differences between rows at $P < 0.010$. Upper case letters indicate significant differences between columns at $P<0.010$.

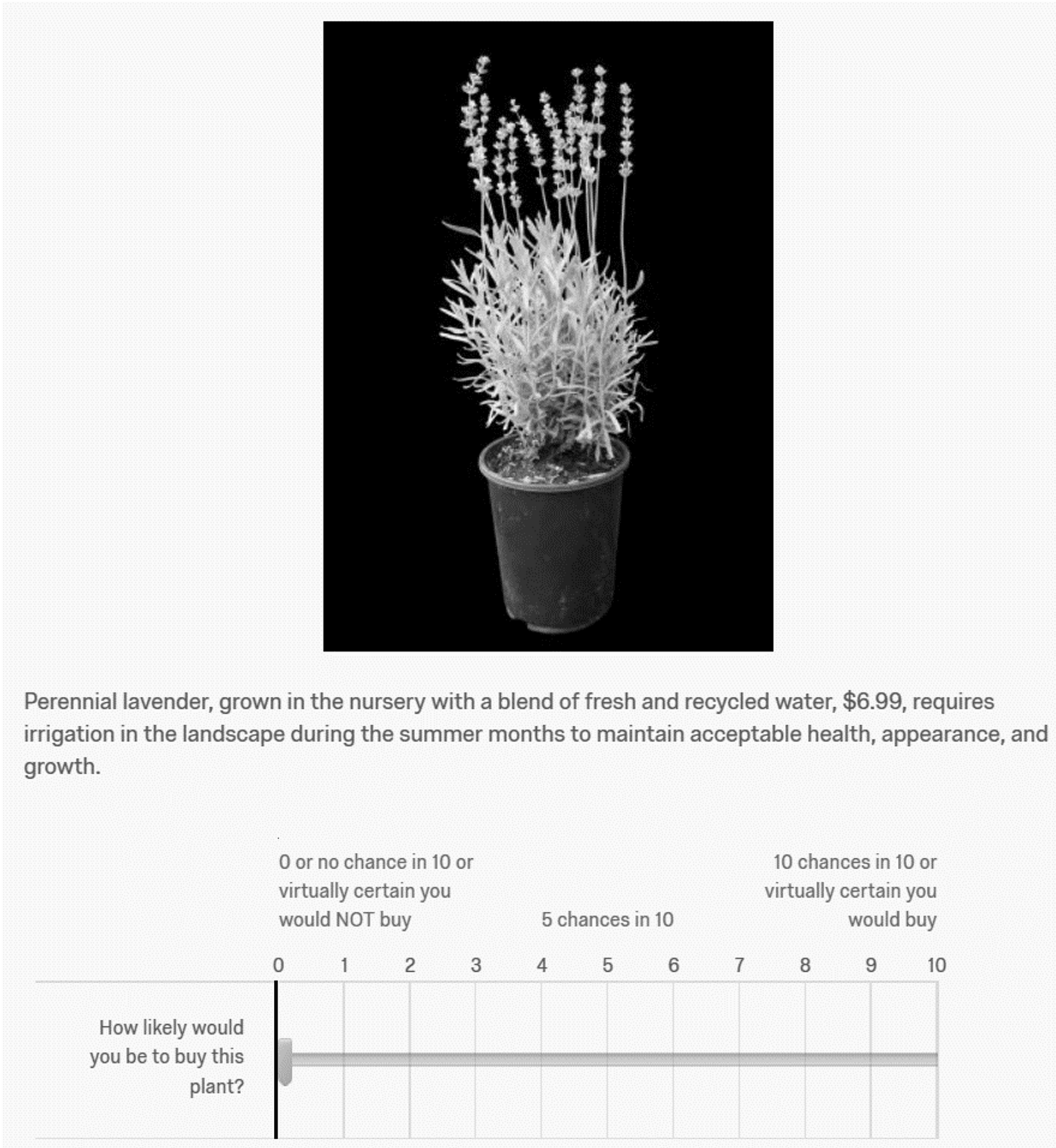

Figure 3.1 An example screenshot of one conjoint image shown to 1543 subjects in online survey pertaining to plant water source and landscape water needs.

4. CONSUMER INVOLVEMENT WITH AND EXPERTISE IN WATER CONSERVATION AND PLANTS AFFECT LANDSCAPE PLANT PURCHASES, IMPORTANCE, AND ENJOYMENT*

It not only important to look at how attributes of a water conserving plants are perceived by the horticulture consumers, but also what influences purchasing decisions. The decline in potable water supplies heightens the competition for water resources and potentially reduces demand for outdoor plantings and landscaping. In this study, we decipher homeowner expertise and involvement in water conservation, plant expertise and involvement, and horticultural importance. We then compare these factors to the respondents' demographic characteristics.

4.1 Literature Review

The challenge to allocate water resources in urban, suburban, rural, and agricultural areas will likely intensify in the coming decades as competition for potable water supplies increases (Springer, 2011). Approximately 35% of domestic potable water, water fit for human consumption, is used for irrigation, 45% is used for thermoelectric production, and only 9% for public potable water supplies (U.S. Geological Service, 2018). Compared to personal direct water uses (e.g. drinking, brushing teeth, etc.), outdoor indirect water use (e.g. watering gardens, lawns, and landscapes) is discretionary. While water for irrigation meets a physical need for the plants, the water indirectly meets a psychological need by elevating homeowners perceived social status through aesthetically pleasing landscapes

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(Seyranian et al., 2015). In addition, landscape provide tremendous economic, environmental, and well-being benefits (Hall and Dickson, 2011). Thus, homeowner perceptions about water use and conservation may be related to their perceptions about the importance of plants and landscapes. Attitudes about water conservation, plants, and the importance of landscaping can potentially influence the investment of water resources in existing and future landscapes and, in turn, dramatically affect the future sales of landscape plants.

Demographic characteristics influence residential water use and conservation. Being female is positively correlated with the adoption of drought-tolerant plants as well as water conservation and environmentalism (Gilg and Barr, 2006; Fan et al., 2017); male heads-of-households were 20% less likely to adopt use of drought tolerant plants (Fan et al., 2017). Gregory and Leo (2003) found a slight positive relationship between income and household water use, as did Domene and Saurí (2006). Older individuals had a greater likelihood of water conservation, but increased knowledge and general education appeared to be more directly linked to conserving water (Gilg and Barr, 2006; St. Hilaire et al., 2010).

Lifestyle influences water use. For individuals with high aesthetic and recreational priorities, outdoor water use is high (Gregory and Leo, 2003; Syme et al., 2004; Beal et al., 2013; Springer, 2011; Fan et al., 2017). Jorgenson et al. (2009) and Syme et al. (2004) showed higher outdoor water use was related to more recreational activities at the residence, higher perceived garden/landscape value, increased spending on their garden or landscape, and disliked paying an increasing price for water. Householders who perceived their landscape would increase the resale value of their house used more water annually, as did persons who spent more time outdoors (Syme et al., 2004). Mayer et al. (1999) reported U.S. households with a garden used 30% more water compared to households that did not maintain one.

Recent research suggests attitudes towards the uses of potable water supplies have changed in other countries due to greater social awareness and increasingly widespread exposure to drought conditions, which included more pro-conservation behavior (Beal et al., 2013). Education about and adoption of sustainable water use practices may help ensure an adequate supply of irrigation water while conserving water sources for human and ecosystem services. Not only have some attitudes changed, but purchase behavior has changed to include more pro-conservation products. Some research suggests consumers are willing to pay more for plants grown using more environmentally friendly practices, including water conservation in plant production (Hall et al. 2010; Behe et al., 2013).

Knuth et al. (2018a) showed some attitudinal differences toward water conservation among three groups of subjects who accurately or inaccurately perceived they had been in a drought situation relative to whether they actually had experienced a drought. Among all plant types listed, a greater percentage of those who accurately perceived they were in a drought had purchased evergreen trees and shrubs compared to those who did not accurately perceive a drought. The group that did not accurately perceive the drought placed a higher value on nursery plants grown with fresh water (versus recycled water or a blend of fresh and recycled water) compared to those who accurately perceived a drought. Knuth et al. (2018b) showed U.S. consumers valued the production water source more than plant water use in the landscape for both herbaceous and woody shrubs. Their conclusion was that education about contents of recycled water may facilitate greater acceptance, and ultimately use of, recycled water. Each of these studies highlight the diversity of consumer water use and perceptions of water use and conservation. Here we address consumer perceptions of residential landscape water conservation, landscape plants, and consumer involvement and expertise.

4.1.1 Involvement and Expertise

Involvement is defined as a person's perceived relevance of an object based on inherent interests, values, or needs; or ''a state of arousal, interest or motivation'' in a product (Behe et al., 2015; Greenwald and Leavitt, 1984; Petty and Cacioppo, 1986; Zaichkowsky, 1985). Consumer involvement with a product has a strong, positive relationship with purchase intention (Lin and Chen, 2006). Involvement level affects the type of information processed prior to the consumers' purchase decision. For example, highly-involved consumers were more likely to examine more inherent product attributes (e.g. plant form, flower color, etc.), while less involved consumers were more likely to consider extrinsic product cues (e.g., brand name and price) because extrinsic cues are cognitively processed compared to intrinsic cues (Behe et al., 2015; Greenwald and Leavitt, 1984).

Involvement level with plants was directly related to visual attention to the plants in a recent choice experiment (Behe et al., 2015). In that study, plant involvement was measured with a 15-item scale (which originated from Zaichkowsky, 1985). Participants who had a high score on plant involvement paid more attention to the product and signage compared to the participants who scored lower on that scale. Thus, the more highly involved consumers processed information more deliberately than consumers with low involvement scores, which indicates the low-involvement group was quickly dismissive of the display information and may not have used information as thoughtfully in their purchase decision. Gregory and Leo (2003) found involvement with water conservation was negatively related to water use in their study of Australian householders. They also used Zaichkowsky's (1985) involvement scale to measure involvement with water conservation. Additionally, Joo et al. (2016) showed involvement and expertise affected the information consumers viewed and their purchase decision.

Expertise is an instinctive response that arises from training, practice, or time spent learning about a particular topic (Hoffman, 1998; Mylopoulos and Regehr, 2007). Prior studies have shown consumers who are more knowledgeable about a product make purchase decisions in a different manner compared to consumers who are less knowledgeable (Grewal et al., 1998). Alba and Hutchinson (1987) and Shanteau (1992) reported consumers with high product expertise were more selective of the information they examined prior to making a choice since they had a better understanding of what product attributes should be examined. Consumers with different expertise levels differ in their ability to comprehend information and discern more pertinent information from less pertinent information (Celsi and Olson 1988; Rao and Sieben, 1992). For example, a wine expert would examine the type of grape and provenance whereas a novice may examine the logo or brand.

Expertise may not necessarily interact with involvement because involvement is a motivational construct, whereas expertise is a sustaining construct representing a person's ability or knowledge to evaluate a particular topic (Batra and Ray, 1986; Zaichkowsky, 1985). In practice, involvement and expertise are often highly correlated, but theoretically distinct from each other (Petty et al., 1981). Therefore, we investigated these constructs separately.

A peer-reviewed study of consumer perceptions about water conservation, plant or landscape importance, and expertise and involvement was conducted with Australian consumers at least a decade ago (Syme et al., 2004). Together these studies suggested the inclusion of involvement and expertise measure in landscape water conservation studies were important because from those findings, researchers could summarize the extent to which consumers were involved with water conservation in their landscape and how confident they were in their knowledge. The findings with Australian consumers could be used as a baseline estimate for American consumers' involvement and expertise.

Our objectives were to investigate the relationship between water conservation involvement and expertise and plant expertise and involvement as well as the perceptions of the importance of plants and landscaping. We hypothesized that water conservation involvement and expertise may be negatively related to plant expertise and involvement and the importance of landscaping since individuals with high aesthetic and recreational priorities, use more water outdoors (Beal et al., 2013; Fan et al., 2017; Gregory and Leo, 2003; Springer, 2011; Syme et al., 2004). Another objective of our study was to determine how consistent U.S. consumers might be with the published Australian findings (Syme et al., 2004), given there are many similarities between the two nations, among them business ethics (Wood, 2000). Information from this investigation could inform marketing strategies of U.S. producers of landscape plants that use less water in the landscape as well as retail point-of-purchase (POP) displays, educational seminars and events hosted by retailers for consumers. Insight gained could improve the understanding of consumer groups who do or do not engage in water conservation activities.

4.2 Materials and Methods

The survey used in Chapter 2 and 3 was also used for Chapter 4. The survey was comprised of five parts: 1) types and amounts of plants purchased; 2) two series of questions in a conjoint design for perennials and (separately) woody shrubs (see Knuth et al. 2018b for a summary of those findings); 3) water conservation knowledge and involvement measures; 4) plant knowledge and involvement measures, and (5) demographic characteristics. For this chapter, we used the water conservation knowledge and involvement measures and plant knowledge and involvement measures. The questions utilized a 7-point Likert scale (1 = very unlikely; 7 = very likely) to rate each question.

Principal component analyses are used to describe the strength and direction of correlated variables in terms of their potential to quantify unobservable constructs (Jolliffe, 1986). The values that emerge show the interdependencies between observed variables which can be collapsed to a smaller set of components. The key result in a principal component analysis is the independent variables' association with an indirectly measured construct or component. We used SAS version 9.4 to conduct three separate principal component analyses-involvement, expertise and importance. In each analysis, we retained items with loadings ≥ 0.500. "Load" or "loading" is the terminology used in principle component analyses to indicate the mean value for each item (question) being the highest among all the mean values for that item when testing for linear combinations) (Hair et al., 1998; Costello and Osborne, 2005). Solutions (component values) with a Cronbach's alpha level of ≥ 0.7 are considered to have a strong measure of internal consistency or validity (Tavakol and Dennick, 2011).

The components identified in those analyses are useful in segregating a sample into smaller clusters or market segments. Kaufman and Rousseeuw (2005) stated cluster analysis, "is the art of finding groups in data" (page 1). Using only the two components identified from the principal component analysis of water conservation expertise and involvement, we conducted an agglomerative cluster analysis using SPSS (version 25) k-means clustering procedure, saving cluster membership for comparisons and mean testing using the demographic characteristics and the other components identified in the prior analyses. A k-means cluster analysis was chosen over hierarchical cluster due to past literature indicating k-means to be more appropriate for consumer preference studies (Lawless, 2010).

An ANOVA analysis was conducted to test for any demographic characteristics differences as well as plant related expenditures and purchased in eight plant categories: annuals, perennials, herb transplants, vegetable transplants, flowering shrubs, evergreen shrubs, fruiting trees, flowering trees, and evergreen trees. This was included to assess if there were true differences among the clusters, and if participating more with water conservation made consumers more or less in tune with purchasing plants from certain categories of plants, or overall had an effect on plant purchasing. We used SPSS Principle Component Analysis. What procedure, what program, what confidence level. K-Means cluster, ANOVA demographics. We used a 10% confidence level.

4.3 Results

4.3.1 Principal Component Analysis

Results of the principal component analysis of 23 items related to water conservation expertise and involvement yielded four components identified as Water Conservation Expertise, Involvement, Importance and Impact (Table 4.1).

The first component to emerge was labeled Water Conservation Expertise. Items that loaded > 0.5 with it included items such as “In general, I know a lot about water conservation”, “I consider myself knowledgeable about water conservation” and “I am knowledgeable about water conservation.”

The second component to emerge was labeled Water Conservation Involvement. Five items loaded > 0.5 on this component and included items “I think that water conservation is boring/exciting” and “I think that water conservation is mundane/fascinating.”

The third component to emerge was labeled as Water Conservation Importance. Four items loaded > 0.5 with this component included “I think that water conservation is unimportant/important” and “I think that water conservation means nothing/is of great importance to me.”

The fourth component to emerge was labeled Water Conservation Impact and had three items with loadings > 0.5. Those items included “I live in an area that had water restrictions in 2016”, “The price of water restricts what I can do in the landscaped areas outside my home”, and “I schedule my irrigation by using a timer/clock.”

For the second Principle Component Analysis, the principal component analysis of items related to plant expertise and involvement produced a two-component solution with high reliability (Cronbach’s alpha = 0.9753) and accounted for 72.8% of the variance in the items (Table 4.2). Items loading highly on the plant expertise component included “I am a plant expert” and “I know a lot about plants.” Items loading highly on the plant involvement construct included “I think that plants are unappealing/appealing” and “I think that plants are uninteresting/interesting.” These were the same components, “Involvement” and “Expertise”, Syme et al. (2004) identified with Australian consumers.

For the third Principle Component Analysis, the analysis of 23 items relating to horticultural importance adapted from Syme et al. (2004) produced a four-component solution with a Cronbach’s alpha = 0.8571 and accounted for 67.1% of the variance in the items (Table 4.3). We identified and labeled the four components as Aesthetically Pleasing Landscape, Active Landscape Use and Enjoyment, Non- Landscape Use and Enjoyment, Low Maintenance Landscape Desire and Response in Drought.

The first component to emerge was Aesthetically Pleasing Landscape which contained items with responses to “How important is each of the following to the preferred lifestyle of you and your family” including “A lush landscape”, “A landscape that is the envy of the neighbors”, “A well-irrigated landscape” , “Large areas of lawn at your property” , “A vibrant landscape”, “A landscape that adds value to my home”, “Large areas of garden beds at your property”, and “A landscape that is into the neighborhood”. All of the items in Aesthetically Pleasing Landscape component are related to landscape beautification and maintenance.

The second component to emerge was identified as Active Landscape Use and Enjoyment and contained six items: “Working with plants outdoors is a valuable way to spend time”, “Working with plants outdoors is a pleasant break from my other activities”, “I get great satisfaction from working in the outdoor landscaped areas around my home”, “I like to enjoy the harvest from my outdoor vegetables and herbs”, “I like to enjoy the look and feel of a nicely landscaped outdoor area”, and “I do not like working with outdoor plants.” All of the items in Active Landscape Use and Enjoyment are related to positive landscape experiences.

The third component to emerge was called Non- Landscape Use and Enjoyment and contained four items: “I hardly ever use the outdoor space at my home for recreation”, “I never entertain friends outdoors”, “The outdoor space around my home is an important place for my leisure activities” (negatively), and “My family makes a lot of use of the outdoor space at our home” (negatively). All of the items in Non- Landscape Use and Enjoyment are related to negative views or experiences of landscape use.

The fourth component to emerge contained three items and was labeled Low Maintenance Landscape Desire. This component contained “A landscape with low maintenance”, “A landscape that uses no supplemental irrigation”, and “A landscape that uses plants with low water requirements.” All of the items in Low Maintenance Landscape Desire are related to low effort or low input in landscape maintenance.

The fifth factor to emerge was labeled Response in Drought and contained two items: “In a water crisis, we should not buy or try to maintain outdoor landscape plants” and “I have decreased my outdoor plant purchases due to water restrictions in my neighborhood.”

4.3.2 Cluster Analysis

Two clusters emerged from the analysis using the principle component analysis base only on only two dimensions: water conservation expertise and involvement. The clusters that emerged were labeled Disinterested in Water Conservation (49.7% of the sample) and Actively Interested in Water Conservation (50.3% of the sample).

We conducted a non-polynomial ANOVA analysis of the demographic characteristics of the clusters including gender, age, ethnicity, household number of adults and children, education level, income, and expenditures on plant-related products in 2016 (Table 4.4). Overall, the Actively Interested cluster had younger, more ethnically diverse, members who were more highly educated and had larger households and higher incomes compared to the Disinterested cluster members.

The Actively Interested cluster spent 91% more ($156.06) on plant-related products in 2016 compared to the Disinterested cluster ($81.91) (Table 4.5). Furthermore, a higher percentage of members of the Actively Interested in Water Conservation cluster purchased the eight plant types listed (Table 4.5) in 2016. The Disinterested cluster did make plant purchases, but not to the extent the Actively Interested cluster did. For the herbaceous plant material (e.g. annuals, vegetables, herbs, and perennial transplants), twice as many Actively Interested cluster members purchased plants. For the woody plants, three to five times the percentage of Actively Interested cluster members bought flowering and evergreen shrubs as well as fruit, shade, and evergreen trees.

Lastly, we compared the mean component scores of the two clusters on the 11 components identified in prior analyses (Table 4.6). The Actively Interested in Water Conservation cluster members had a higher mean score on 10 of the 11 components including water conservation expertise and involvement, water conservation importance and impact, plant expertise and involvement, aesthetic landscape beauty, desire for low maintenance landscape and response in drought. The exception was the component labeled

Non- landscape use or enjoyment for which the Disinterested in Water Conservation cluster members scored higher compared to the Actively Interested in Water Conservation members.

4.4 Discussion

The objectives of this study were to explore the relationship between water conservation involvement and expertise, and plant expertise and involvement, and correspondingly understand the perceptions of the importance of plants and landscaping for American consumers. Behe et al. (2015) and Joo et al. (2016) conducted a principal component analysis of scales using the same terminology as in the current study and found only two dimensions: expertise and involvement. In this study, we found similar results with the emergence of two dimensions of plant expertise and plant involvement. However, four components emerged in the water conservation analysis. Both importance and impact of water conservation emerged as distinct from expertise and involvement. The difference between the present findings and Syme et al. (2004) may indicate that water conservation may be a more complex set of constructs, than Syme et al. (2004), which includes distinct dimensions for importance and impact. The components had sufficiently high reliability and validity that they can be replicated in future studies.

Syme et al. (2004) reported their factor of analysis landscape and horticultural importance (items we adapted are listed in Table 4.3) without publishing the item loadings, amount of variance accounted for, and fit statistics. Their solution contained five factors: lifestyle, garden recreation, garden interest, conservation attitude, and social desirability. Our first component to emerge (Aesthetically Beautiful Landscape) was similar to Syme et al.'s (2004) lifestyle factor. Their garden recreation factor emerged as two components in our analysis: Active Landscape Use and Enjoyment, and Non- Landscape Use and Enjoyment. Their conservation attitude factor was similar to our component Low Maintenance Landscape Desire. Our reduced plant use component was similar to their social desirability factor. Yet, without the publication of their item loadings and fit statistics, it is not possible to make a more detailed comparison. While we cannot test statistically for similarities (or differences), we see consistency in the findings of the present study and Syme et al. (2004).

The two-solution cluster analysis provides evidence the market is not homogeneous based on water conservation involvement and expertise attitude dimensions. We did find differences in the sample of participants by plant and water conservation expertise and involvement as well as horticultural importance and demographic characteristics. The resulting two-cluster solution indicated that there are two key target market for marketers to communicate with, and they appear to have opposite perceptions of water conservation involvement and expertise as well as plant involvement and expertise. Their demographic and attitudinal characteristics can also help facilitate the development of marketing strategies to target them. For example, to target Active Water Conservers, it may be helpful to provide more water conserving plants and communicate the benefits of including water conserving plants in their landscape.

Demographically, the Actively Interested cluster was younger than the Disinterested group, which was opposite the findings of Gilg and Barr (2006) and St. Hilaire et al. (2010). The Actively Interested cluster also had more adults and children in the household, consistent with Behe et al. (2014) and Mayer (1999). This cluster also had a higher household income compared to the Disinterested in Water Conservation segment, which was more consistent with Gregory and Leo (2003) but not Domene and Saurí (2006). A younger and more affluent segment that is actively concerned about water conservation could represent a changing perception of younger generations.

Behaviorally, the two clusters differed substantially. It was not that the Disinterested did not purchase plants, because they did. In fact, approximately half of the Disinterested segment purchased herbaceous transplants of annuals, vegetables, herbs, and perennials. However, purchases of woody plants were three to five times as great for Actively Interested individuals compared to Disinterested individuals. The Actively Interested individuals are more interested in their landscapes and are substantially investing in the infrastructure of their landscape consisting of woody plants that will persist and increase in size and value. This finding could be great news for woody plant producers who can offer woody plants that would perform well under low water use conditions.

Attitudinally, the two clusters differed on every (principal component) attitude identified in the study. The Actively Interested in Water Conservation cluster considered water conservation more important and having a bigger impact on their lifestyle compared to the Disinterested segment. Actual water use of individuals who are Actively Interested in Water Conservation would be interesting to measure since Gregory and Leo (2003) demonstrated that involvement with water conservation was negatively related to water use in their study of (Perth) Australia householders. Their findings may be due, in part, to prolonged and severe drought periods experienced in Australia, especially the cities. Still, prior research showed individuals with high aesthetic and recreational priorities (Gregory and Leo, 2003; Syme et al., 2004; Beal et al., 2013; Springer, 2011; Fan et al., 2017) or who spent more time outdoors (Syme et al., 2004) used more water.

Furthermore, the Actively Interested segment had higher plant expertise and involvement, indicating they believe they know more about plants and are more interested in plants compared to the other segment. Lin and Chen (2006) demonstrated consumer involvement with a product has a strong, positive relationship with purchase intention and we documented a higher level of plant involvement was positively related to more plant purchases. The Actively Interested segment valued aesthetically beautiful landscapes more, actively enjoyed landscapes more, had a greater desire for low maintenance landscapes, and had a more positive response in drought. Plants and landscaping are important to the segment of Americans who are interested in (involved) and have knowledge about (expertise) water conservation. The pro-active water conserving attitudes of the Actively Interested segment also appear to be consistent with Gregory and Leo (2003). This is very good news for the horticulture industry because professionals may concentrate on marketing messages that highlight differences in landscape plant performance under drought conditions rather than needing to make the landscape an important part of the potential consumers' lifestyle. While garden retailers do not typically focus marketing messages which make the landscape a priority for consumers' dollars and water, a message including those items could be combined with information on water-saving cultivars. In other words, landscaping doesn't have to be a large water-user.

The disconcerting aspect of the half of the sample that comprised Disinterested in Water Conservation segment is that they do not use or enjoy their outdoor landscapes very much. They also spent half the amount on plants compared to the Actively Interested in both 2015 and 2016. The implication from this is that growers, wholesalers, and retailers should focus more on educating potential consumers about which plants to buy and, ultimately, why they should buy plants. Marketing messages could help them place a higher priority on landscaping and the tremendous economic, environmental, and health and well-being benefits derived from having plants around residences and businesses (Hall and Dickson, 2011).

4.5 Conclusion

Horticultural industry stakeholders should be encouraged by these findings. Americans who are actively interested in water conservation find plants important, have an active use and enjoyment of the landscape, and a desire for lower inputs in those landscapes, especially water. This appears to be good news since Mayer et al. (1999) reported households who maintained a garden used 30% more water than those without a garden. Thus, the 50% of homeowners who are actively interested in conservation would likely place a high priority on water availability for outdoor uses even when water resources are scarce. They derived enjoyment from their landscape and were active in it. The industry should capitalize on that enjoyment by directing future purchases to species and cultivars with lower water needs.

The implications for the Green industry are clearer. Their energy should be invested in marketing and communication strategies that emphasize cultivar selection for low inputs, including water. It would appear the industry does not need to convince individuals with high water conservation involvement that plants are important, nor do they need to promote water conservation importance to individuals with high plant involvement. The value of both plants and water conservation are related. However, three to five times more individuals who value the landscape (and scored high on water conservation involvement and expertise) are investing in the backbone of the landscape, which is woody plants.

Limitations of this study include potential biases in the panel used to supply respondents to the survey. The unintentional omission of Hawaii through subject recruitment may influence generalizability to the U.S. populations slightly. Lastly, actual water use measures would have strengthened the results but dramatically increased the survey length and response time. Future work should investigate the relationships between actual water use and the principal components identified here.

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Table 4.1 Principal component analysis of 23 items with oblique rotation (Promax) consisting of loadings from 28 initial items relating to water conservation expertise and involvement.

Item	Water conservation Expertise	Water conservation Involvement	Water conservation Importance	Water conservation Impact
In general, I know a lot about water conservation	0.9377	0.0205	-0.0425	-0.0548
I consider myself knowledgeable about water conservation	0.9133	0.0449	-0.0081	-0.0586
I am knowledgeable about water conservation	0.9065	0.0391	0.0033	-0.0493
I know a lot about water conservation	0.8213	0.1454	-0.0541	-0.0627
I automatically know how to conserve water	0.7891	-0.1467	0.2161	-0.0509
My knowledge of water conservation helps me to understand very technical information about it	0.7540	0.1467	-0.1237	0.1350
I am involved with water conservation	0.7346	-0.0082	0.1369	0.0688
I keep current on the most recent developments about water conservation	0.6856	0.1636	-0.0008	0.1657
I am a water expert	0.6505	0.2502	-0.2815	0.1538
Compared to other people, I am interested in water conservation	0.6085	0.3094	0.0676	-0.0763
I use fixtures that help me to conserve water at home	0.5513	-0.1403	0.2789	0.1435
I think that water conservation is (1 --"boring" to 5 -- "exciting")	0.0317	0.8619	0.0280	0.0419
I think that water conservation is (1 -- "mundane" to 5 -- "fascinating")	0.0229	0.8536	0.0903	-0.0039
I think that water conservation is (1 -- "uninteresting" to 5 -- "interesting")	0.0194	0.6934	0.3043	-0.0397

Table 4.1 Continued.

Item	Water conservation Expertise	Water conservation Involvement	Water conservation Importance	Water conservation Impact
I think that water conservation is (1 -- "unappealing" to 5 -- "appealing")	0.0765	0.6768	0.2690	-0.0430
I enjoy learning about water conservation	0.3430	0.5951	0.0530	-0.0018
I think that water conservation is (1 -- "unimportant" to 5 -- "important")	-0.1026	0.1821	0.8052	-0.0025
I think that water conservation (1 -- "means nothing to me" to 5 --"is of great importance to me")	-0.0114	0.2722	0.7541	0.0221
I think that water conservation is (1 -- "of no concern to me" to 5 -- "of great concern to me")	-0.0051	0.2475	0.7491	0.0591
I conserve water in and around my home	0.5849	-0.2266	0.5582	-0.0155
I live in an area that had water restrictions in 2016	-0.0074	-0.1030	0.0776	0.8292
The price of water restricts what I can do in the landscape areas outside my home	-0.0501	0.1456	0.0030	0.7362
I schedule my irrigation by using a timer/clock	0.3045	-0.0660	-0.0131	0.5692
Percent of Variance	34.2%	16.9%	13.2%	7.7%
Variance Explained (Before Rotation)	11.6967	2.6261	1.1742	1.0809
Variance Explained (Orthogonal Rotation)	7.3294	3.9615	3.2085	2.0785
Variance Explained Eliminating Other Components (Oblique Rotation)	4.2365	2.0845	1.9822	1.3144
Variance Explained Ignoring Other Components (Oblique Rotation)	10.2607	7.7097	5.2268	4.0951

Table 4.1 Continued.

Item	Water conservation Expertise	Water conservation Involvement	Water conservation Importance	Water conservation Impact
Cronbach Coefficient Alpha – Raw Variables	0.9494	0.9510	0.9534	0.9528
Cronbach Coefficient Alpha – Standardized Variables	0.9520	0.9533	0.9555	0.9557
Cronbach Coefficient Alpha – Raw Variables (Overall)		0.9509		
Cronbach Coefficient Alpha – Standardized Variables (Overall)		0.9534		

Note: Five items were removed due to loadings lower than 0.500 or less with all components. Four components emerged from the 23 item loadings. The four components that emerged were Water Conservation Expertise, Water Conservation Involvement, Water Conservation Importance, and Water Conservation Impact. A UNIVARIATE Procedure was conducted using SAS software (SAS for Windows, version 9.4, SAS Institute Inc., Cary, North Carolina). Loadings in bold indicate item component assignments. These loadings indicate which component the item was categorized with based on highest item value.

Table 4.2 Principal component analysis of 26 items with oblique rotation (Promax) with loadings of 27 initial items relating to plant expertise and involvement.

Item	Plant Expertise	Plant Involvement
I am a plant expert	0.9532	-0.2263
I know a lot about plants	0.9328	-0.0119
In general, I know a lot about plants	0.9322	-0.0211
I am knowledgeable about plants	0.9190	0.0062
I can recall specific attributes about plants	0.8658	0.0199
My knowledge of plants helps me to understand very technical information about them	0.8631	-0.0283
I consider myself knowledgeable about plants	0.8578	0.0681
I can recognize many types of plants	0.8305	0.0437
I automatically know which plants to buy	0.8229	-0.0064
I can recognize many names of plants	0.7963	0.0437
I can recall many plants from memory	0.7931	0.0437
I keep current on the most recent developments about plants	0.7726	0.0791
I can immediately identify my preferred plants even if they are displayed with others	0.6914	0.1833
I will search the latest information on plants before I make a purchase	0.6829	0.1015
At the place of purchase, I can visually detect my preferred plants without much effort	0.6290	0.2356
Compared to other people, I am interested in plants	0.6177	0.3313
Because of my personality, I would rate plants as being of the highest importance to me, personally.	0.5929	0.2811
I am involved in growing plants	0.5706	0.3176
I enjoy learning about plants	0.5611	0.4023
I think that plants are (1--"unappealing to 5 --"appealing")	-0.1517	0.9419
I think that plants are (1--"uninteresting" to 5--"interesting")	-0.0122	0.9114
I think plants are (1-- "unimportant" to 5-- "important")	-0.0459	0.8693
I think that plants are (1--"mundane" to 5--"fascinating")	0.0292	0.8580
I think that plants (1--"mean nothing to me" to 5--"are of great importance to me")	0.1478	0.8100
I think plants are (1--"boring" to 5--"exciting")	0.1220	0.7962
I think that plants are (1-"of no concern to me" to 5--"of great concern to me")	0.1339	0.7954

Table 4.2 Continued.

Item	Plant Expertise	Plant Involvement
Percent of Variance	52.1%	20.7%
Variance Explained (Before Rotation)	16.1829	2.7430
Variance Explained (Orthogonal Rotation)	11.8818	7.0441
Variance Explained Eliminating Other Components (Oblique Rotation)	7.8984	3.8692
Variance Explained Ignoring Other Components (Oblique Rotation)	15.0567	11.0275
Cronbach Coefficient Alpha -- Raw Variables	0.9764	0.9773
Cronbach Coefficient Alpha - Standardized Variables	0.9764	0.9772
Cronbach Coefficient Alpha -- Raw Variables (Overall)	0.9755	
Cronbach Coefficient Alpha -- Standardized Variables (Overall)	0.9753	

Note: Two components emerged from the 26 item loadings. Items were removed from the analysis if they loaded 0.500 or less with all components. The two components that emerged were Plant Expertise and Plant Involvement, which were distinctly similar to Syme et al. (2004). A UNIVARIATE Procedure was conducted using SAS software (SAS for Windows, version 9.4, SAS Institute Inc., Cary, North Carolina). Loadings in bold indicate item component assignments.

Table 4.3 Principal component analysis of 23 items with oblique rotation (Promax) with loadings of 27 initial items relating to landscape and plant importance adapted from Syme et al. (2004).

Item	Aesthetically Pleasing Landscape	Active Landscape Use and Enjoyment	Non-Landscape Use and No Enjoyment	Low Maintenance Landscape Desire	Response in Drought
A lush landscape	0.8431	0.0286	0.0058	-0.0700	-0.0326
A landscape that is the envy of the neighbors	0.8118	-0.0098	0.0961	-0.0378	0.0307
A well-irrigated landscape	0.7929	-0.0425	0.0282	0.0377	0.0081
Large areas of lawn at your property	0.7537	-0.0535	-0.1257	-0.1259	0.0761
A vibrant landscape	0.6454	0.1263	0.0223	0.2319	-0.1212
A landscape that adds value to my home	0.5420	-0.0100	-0.0117	0.4484	-0.1620
Large areas of garden beds at your property	0.5326	0.3706	-0.0866	-0.1333	0.0646
A landscape that fits into the neighborhood	0.5142	-0.1194	0.0078	0.4712	-0.1388
Working with plants outdoors is a valuable way to spend time	0.0243	0.9252	0.0530	0.0160	0.0007
Working with plants outdoors is a pleasant break from my other activities	0.0294	0.9231	0.0434	0.0109	0.0021
I get great satisfaction from working in the outdoor landscaped areas around my home	0.1278	0.8231	-0.0336	-0.0447	0.0437

Table 4.3 Continued.

Item	Aesthetically Pleasing Landscape	Active Landscape Use and Enjoyment	Non-Landscape Use and No Enjoyment	Low Maintenance Landscape Desire	Response in Drought
I like to enjoy the harvest from my outdoor vegetables and herbs	-0.0513	0.6332	-0.0812	0.0297	0.1249
I like to enjoy the look and feel a nicely landscaped outdoor area	0.1568	0.5010	-0.0158	0.2721	-0.0834
I do not like working with outdoor plants.	0.1924	-0.8278	0.0217	0.0477	0.3579
I hardly ever use the outdoor space at my home for recreation	0.1124	0.0325	0.9179	-0.0081	0.1815
I never entertain friends outdoors	0.0604	0.0425	0.8526	-0.0251	0.2103
The outdoor space around my home is an important place for my leisure activities	0.1879	0.1606	-0.6973	0.0106	0.1652

Table 4.3 Continued.

Item	Aesthetically Pleasing Landscape	Active Landscape Use and Enjoyment	Non-Landscape Use and No Enjoyment	Low Maintenance Landscape Desire	Response in Drought
My family makes a lot of use of the outdoor space at our home	0.1629	0.0990	-0.7500	-0.0090	0.1987
A landscape with low maintenance	-0.1229	-0.0986	-0.0404	0.8663	0.0189
A landscape that uses no supplemental irrigation	-0.0521	0.0857	0.0145	0.7297	0.1973
A landscape that uses plants with low water requirements	0.0839	0.2480	0.0055	0.5976	0.1475
In a water crisis, we should not buy or try to maintain outdoor landscape plants	-0.2408	-0.0147	0.0048	0.2087	0.7398
I have decreased my outdoor plant purchases due to water restrictions in my neighborhood	0.1677	-0.0275	0.0984	-0.0532	0.7234

Table 4.3 Continued.

Item	Aesthetically Pleasing Landscape	Active Landscape Use and Enjoyment	Non-Landscape Use and No Enjoyment	Low Maintenance Landscape Desire	Response in Drought
Percent of Variance (Total = 67.1%)	21.9%	18.3%	13.7%	8.1%	5.1%
Variance Explained (Before Rotation)	8.4805	2.6737	1.6311	1.3893	1.2638
Variance Explained (Orthogonal Rotation)	4.3570	4.2127	2.8040	2.5451	1.5197
Variance Explained Eliminating Other Components (Oblique Rotation)	2.6631	2.5392	1.9873	1.8537	1.4431
Variance Explained Ignoring Other Components (Oblique Rotation)	6.5053	6.5292	4.5158	3.8770	1.6321
Cronbach Coefficient Alpha -- Raw Variables	0.8517	0.8563	0.8797	0.8578	0.8640
Cronbach Coefficient Alpha - Standardized Variables	0.8653	0.8700	0.8927	0.8705	0.8779
Cronbach Coefficient Alpha -- Raw Variables (Overall)	0.8390				

Table 4.3 Continued.

Item	Aesthetically Pleasing Landscape	Active Landscape Use and Enjoyment	Non-Landscape Use and No Enjoyment	Low Maintenance Landscape Desire	Response in Drought
Cronbach Coefficient Alpha -- Standardized Variables (Overall)	0.8571				

Note: Five components emerged based on the 27 item loadings. Items were removed from the analysis if they loaded 0.500 or less with all components. The five components that emerged were Beautiful Landscape, Active Landscape Enjoyment, Non- Landscape Enjoyment, Low Maintenance Landscape Desire, and Response in Drought. A UNIVARIATE Procedure was conducted using SAS software (SAS for Windows, version 9.4, SAS Institute Inc., Cary, North Carolina). Loadings in bold indicate item component assignments.

Table 4.4 ANOVA of “Actively Interested in Water Conservation” and “Disinterested in Water Conservation” clusters’ demographics comprising of age, gender, ethnicity, household size for both adults and children, income, and education level.

Demographic Characteristic	Cluster: Disinterested in Water Conservation [Mean (SE)]	Cluster: Actively Interested in Water Conservation [Mean (SE)]	Test Statistic	Significance Level
Age	58.6 (0.56) *	55.3 (0.65) *	t(1508.2) = 3.87	0.0001
Gender	28%	30%	$\chi^2(1) = 2.06$	0.1511
Percent Caucasian	91.9%	83.0%	$\chi^2(1) = 31.26$	0.001
Percent African American	3.0%	4.5%	$\chi^2(1) = 1.59$	0.207
Percent Asian	1.4%	7.1%	$\chi^2(1) = 29.76$	0.000
Percent Other	2.9%	3.0%	$\chi^2(1) = 1.59$	0.207
Number of adults in household	1.1 (0.03) *	1.3 (0.03) *	t(1508.8) = 4.28	0.000
Number of children in household	0.3 (0.03) *	0.6 (0.04) *	t(1420.9) = 6.90	0.000
Income	$63,526.0 ($1,706.25) *	$71,840.4 ($1,720.21) *	t(1508.8) = 4.28	0.000
Percent obtained Bachelor’s Degree	57.7 %	42.5%	$\chi^2(1) = 31.08$	0.000

Note: The test statistic abbreviations are “t” for the t-test, $\chi 2$ for the Chi-Square test, “F” for the F-statistic, and “P” means p-value. Asterisk (*) indicates significant differences between columns at P<0.010. Degrees of freedom are noted in parenthesis along with the test statistic. Tests were conducted using SAS software with adjustments for any unequal variances (SAS for Windows, version 9.4, SAS Institute Inc., Cary, North Carolina).

Table 4.5 ANOVA of “Actively Interested in Water Conservation” and “Disinterested in Water Conservation” clusters’ demographics.

Plant-related Productions	Cluster			
	Disinterested in Water Conservation [Mean (SE)]	Actively Interested in Water Conservation [Mean (SE)]	Test Statistic	Significance Level
Amount spent on plants and related supplies excluding equipment in 2015	\$82.79 (\$4.36)	\$152.98 (\$4.95)	F=106.011	0.000
Amount spent on plants and related supplies excluding equipment in 2016	\$82.36 (\$4.31)	\$147.95 (\$4.79)	F=97.701	0.000
Percent purchasing annual plants	0.40 (0.019)	0.58 (0.017)	$\chi^2(1)$ = 34.569	0.000
Percent purchasing vegetable transplants	37.8%	62.1%	$\chi^2(1)$ = 63.28	0.000
Percent purchasing herb transplants	35.39%	64.6%	$\chi^2(1)$ = 55.224	0.000
Percent purchasing perennials	39.18%	60.8%	$\chi^2(1)$ = 29.254	0.000
Percent purchasing flowering shrubs	28.76%	71.23%	$\chi^2(1)$ = 65.086	0.000
Percent purchasing evergreen shrubs	15.25%	84.74%	$\chi^2(1)$ = 60.672	0.000
Percent purchasing fruit producing trees	25%	75%	$\chi^2(1)$ = 38.786	0.000
Percent purchasing evergreen trees	14.95%	85.05%	$\chi^2(1)$ = 55.553	0.000
Percent purchasing shade trees	21.37%	78.63%	$\chi^2(1)$ = 40.675	0.000

Note: These demographic characteristics comprising spending on plant-related productions in 2016 in average spending in 2015 and 2016, plant purchases in annuals, vegetable transplants, herb transplants, flowering shrubs, evergreen shrubs, fruiting trees, evergreen trees and shade trees. The test statistic abbreviations are χ2 for the Chi-Square test, “F” for the F-statistic, and “P” means p-valuer. Degrees of freedom are noted in parenthesis along with the test statistic. Tests were conducted using SAS software with adjustments for any unequal variances (SAS for Windows, version 9.4, SAS Institute Inc., Cary, North Carolina). Lower case letters indicate significant differences between columns at P < 0.010.

Table 4.6 Comparison of two clusters, “Disinterested in Water Conservation” and “Actively Interested in Water Conservation”, identified in k-means cluster analysis.

Landscape Components	Cluster: Disinterested [Mean (SE)] (n=767)	Cluster: Actively Interested [Mean (SE)] (n=776)	F	Significance Level
Water Conservation Expertise	-0.681 (0.027) *	0.673 (0.026) *	1303.59	0.000
Water Conservation Involvement	-0.658 (0.028) *	0.651 (0.026) *	1155.97	0.000
Water Conservation Importance	-0.487 (0.039) *	0.481 (0.022) *	472.26	0.000
Water Conservation Impact	-0.476 (0.027) *	0.471 (0.036) *	445.8	0.000
Plant Expertise	-0.502 (0.033) *	0.496 (0.03) *	511.05	0.000
Plant Involvement	-0.414 (0.04) *	0.409 (0.023) *	314.35	0.000
Landscape Beauty	-0.36 (0.033) *	0.356 (0.034) *	226.26	0.000
Active Landscape Enjoyment	-0.444 (0.037) *	0.439 (0.026) *	372.99	0.000
Non- Landscape Enjoyment	0.245 (0.038) *	-0.242 (0.032) *	97.22	0.000
Low Maintenance Landscape Desire	-0.286 (0.039) *	0.283 (0.029) *	135.73	0.000
Response in Drought	-0.251 (0.027) *	0.248 (0.041) *	102.32	0.000

Note: Components included Water Conservation Expertise, Involvement, Importance, and Impact; Plant Expertise and Involvement; and Landscape Beauty, Active Landscape Enjoyment, Non- Landscape Enjoyment, Low Maintenance Landscape Desire, and Response to Drought. The abbreviation “F” means F-statistic, “P” means p-value. Asterisk (*) indicates significant differences between columns at P<0.010. Tests were conducted using SAS software with adjustments for any unequal variances (SAS for Windows, version 9.4, SAS Institute Inc., Cary, North Carolina).

5. CONCLUSIONS

With scarcity of water comes the importance of water conservation. Past literature shows the more urbanized the population becomes the more scare water resources become in the population dense areas. With this scarcity comes allocation requirement changes to all organisms, including plants and humans. The research collected and analyzed within this dissertation demonstrates on a national level what homeowners within the United States do regarding water conservation habits and perception. Relatively little information is available about behavior during accurate and inaccurate real and perceived periods. In addition, this is the first time production water sources and landscape water use were combined together in a decision experiment. Understanding how home-owners view water conservation within the landscape is an important step to incorporating more water conscious plants, equipment, and practices into the landscape.

Overall from the results, growers, wholesalers, and retailers can provide more education to their consumers to help facilitate the transition from intensively managed landscapes to including the use of plants or cultivars that use less water. The results are helpful information in that efforts to communicate water source and water needs may be favorably received by consumers. Green industry stakeholders should be encouraged by these findings. Marketing and communication strategies that emphasize cultivar selection for low inputs, including water, should be utilized. It is not a matter of convincing individuals that plants are important, those who are interested in water conservation already find plants to be important and derive enjoyment from them. The industry should capitalize on that enjoyment by directing future purchases to species and cultivars with lower water needs instead of focusing on messaging on plant importance.

The industry thrives due to consumers recognizing the importance of plants. This is one of the ways the industry can keep relevant during drought periods or in economic downturns. Hall and Knuth (2019a, 2019b, 2019c, and 2020) summarizes the benefits of plants in academic literature. These functional health and wellbeing and economic benefits should be used in marketing messages to consumers rather than simply base value proposition on the features and benefits of the plants themselves. This plant messaging can change the perceived value of plants from luxury items to necessity, and thus increasing quality of life for consumers. Keeping plants relevant to consumers, and therefore maintaining the importance of them to actively participating consumers, should always be a primary goal for Green Industry members.

An extension of this research that is currently being pursued is Clean WaterS3 where Consumers will benefit from local, urban specialty crop production that can enhance the urban environment and alleviate food deserts through studying soilless crop systems and water treatment technologies. Other extensions may include an investigative time series analysis of drought perceptions and water needs in states such as Texas, Oklahoma, and parts of California who were previously in drought status but have transitioned into non-drought status. Implications of sustained water conserving habits in these states could be helpful to industry stakeholders messaging strategies.

5.1 Literature Cited

Hall, C., and Knuth, M. 2019a. An update of the literature supporting the well-being benefits of plants: a review of the emotional and mental health benefits of plants. J. Environ. Hort. 37(1): 30-38.

Hall, C. R., and Knuth, M. J. 2019b. An update of the literature supporting the well-being benefits of plants: part 2 - physiological health benefits. J. Environ. Hort. 37(2): 63-73.

Hall, C. R., and Knuth, M. J. 2019c. An update of the literature supporting the well-being benefits of plants: part 3 - social benefits. J. Environ. Hort. 37(4): 136-142.

Hall, C. R., and Knuth, M. J. 2020. An update of the literature supporting the well-being benefits of plants: part 4 - available resources and usage of plant benefits information. J. Environ. Hort. 38(1).

APPENDIX A

ANALYSIS OF UNIQUE CONTRIBUTIONS OF DISSERTATION AUTHOR TO THE SCRI CLEAN WATER3 PROJECT USING SELECTED CRITERIA FOR AUTHORSHIP AS A PROXY FOR ORIGINALITY

Table A.1 NIH guidelines for authorship contributions.

Contributions Determining Authorship		**Knuth Assessment**
Design & Interpretation	Original idea, planning, and input	Knuth made contributions to survey design via her analysis of the literature. Knuth also created a framework context for each of the three main chapters.
	Other intellectual contribution	Knuth developed most of the hypotheses.
Supervisory Role	Supervision of the Project	Knuth sought input when questions arose.
	Training, Education	No
	Mentoring of 1st author	No
Administrative & technical support	Resources: $	No
	Resources: Animals	N/A
	Resources: Patients	N/A
Data acquisition	Original experimental work	Knuth conducted analysis of the data with the supervision of co-authors and confirmation testing with Sage (Behe technician).
	Technical experimental work	Sage/Behe performed routine confirmation testing.
	Data analysis: assays	N/A
	Data analysis: statistical	Yes, Knuth conducted extensive data analyses.
Writing & other	Drafting of manuscript	Knuth conducted the literature search, synthesized the information, and authored the entire literature review. Knuth authored 100% of methodology sections. Knuth authored 75% of the results sections. Knuth authored 50% of the discussion and conclusions sections.
	Reading and commenting on manuscript	Knuth and the entire author team reviewed the manuscript and proofread before submitting to the journals. Knuth addressed reviewers' comments and made revisions.
	None	N/A

Table A.2 Harvard authorship criteria by score (adapted from Kosslyn, 2002).

Item	**Knuth Score**	**Knuth Assessment**
Idea (250 points)	50	Knuth also created a framework context for each of the three main chapters.
The design (100 points)	30	Knuth made contributions to survey design via her analysis of the literature.
Implementation (100 points)	5	Knuth performed minor tasks regarding implementation. Behe was the lead during survey implementation.
Conducting the experiment (100 points)	0	Knuth did not interact with the subjects. Behe and Sage interacted with the subjects.
Data analysis (200 points)	190	Knuth conducted the data analyses. This was confirmed through confirmatory analyses with Sage and supervision by Behe.
Writing (250 points)	200	Knuth conducted the literature search and authored the entire literature review. Knuth authored 100% of methodology sections. Knuth authored 75% of the results sections. Knuth authored 50% of the discussion and conclusions sections. Behe, Hall, Huddleston, and Fernandez contributed additional discussion and conclusions from what Knuth authored. Knuth addressed reviewers' comments and made revisions.
Total Contribution	**475/1000**	

Note: Kosslyn, Stephen M. Nov. 2002. Criteria for Authorship. Kosslyn Lab Files, John Lindsley Professor of Psychology. Harvard University. <https://kosslynlab.fas.harvard.edu/files/kosslynlab/files/authorship_criteria_nov02.pdf>

Table A.3 Plos One guide to authorship contributions.

Contributor Role	Role Definition	Knuth Assessment
Conceptualization	Ideas; formulation or evolution of overarching research goals and aims.	The grant proposal was developed, and funding awarded before Knuth was a student was at TAMU. Knuth also created a framework context for each of the three main chapters.
Data Curation	Management activities to annotate (produce metadata), scrub data and maintain research data (including software code, where it is necessary for interpreting the data itself) for initial use and later reuse.	Behe and Sage de-identified data. Knuth was responsibility for data management through shared Dropbox including providing the output reports to indicate all of the statistical coding.
Formal Analysis	Application of statistical, mathematical, computational, or other formal techniques to analyze or synthesize study data.	Knuth conducted analysis of the data with the supervision of co-authors and confirmation testing with Sage (Behe technician).
Funding Acquisition	Acquisition of the financial support for the project leading to this publication.	The grant proposal was developed, and funding awarded before Knuth was a student was at TAMU.
Investigation	Conducting a research and investigation process, specifically performing the experiments, or data/evidence collection.	Knuth performed minor tasks regarding implementation. Behe was the lead during survey implementation.
Methodology	Development or design of methodology; creation of models	Knuth synthesized and created a context for the framework of each of the three papers.
Project Administration	Management and coordination responsibility for the research activity planning and execution.	Knuth did not interact with the subjects. Behe and Sage interacted with the subjects.
Resources	Provision of study materials, reagents, materials, patients, laboratory samples, animals, instrumentation, computing resources, or other analysis tools.	Hall purchased statistical tools to analyze data (Advanced SPSS license).
Software	Programming, software development; designing computer programs; implementation of the computer code and supporting algorithms; testing of existing code components.	N/A
Supervision	Oversight and leadership responsibility for the research activity planning and execution, including mentorship external to the core team.	Knuth sought input when questions arose.

Validation	Verification, whether as a part of the activity or separate, of the overall replication/reproducibility of results/experiments and other research outputs.	Sage/Behe performed routine confirmation testing of Knuth's analyses outputs.
Visualization	Preparation, creation and/or presentation of the published work, specifically visualization/data presentation.	Knuth generated visuals and tables for publications.
Writing – Original Draft Preparation	Creation and/or presentation of the published work, specifically writing the initial draft (including substantive translation).	Knuth conducted the literature search, synthesized the information, and authored the entire literature review. Knuth authored 100% of methodology sections. Knuth authored 75% of the results sections. Knuth authored 50% of the discussion and conclusions sections.
Writing – Review & Editing	Preparation, creation and/or presentation of the published work by those from the original research group, specifically critical review, commentary or revision – including pre- or post-publication stages.	Behe, Hall, Huddleston, and Fernandez contributed additional discussion and conclusions from what Knuth authored. Knuth addressed reviewers' comments and made revisions.

Table A.4 Elsevier guide to authorship contributions.

Role	**Contributor**
Study conception and design	Behe, Fernandez, Hall, Huddleston, Knuth
Acquisition of data	Behe
Analysis and interpretation of data	Knuth, Behe, Hall
Drafting of manuscript	Knuth, Behe
Critical Revision	Knuth, Behe, Fernandez, Hall, Huddleston

APPENDIX B

BIOSKETCH

Melinda Knuth

Horticulture Ph.D. Candidate

Texas A&M University

Melinda Knuth's primarily research goal is to quantify how consumers place valuation by deciphering attitudes and perceptions through eye-tracking technology and intrinsic behavioral assessments. She is currently a doctoral student of Dr. Charlie Hall. Melinda also works with Dr. Bridget Behe, Michigan State University and Dr. Marco Palma, Director of Texas A&M University's Human Behavior Lab.

Melinda received a B.S. in Horticulture Entrepreneurship from the University of Nebraska-Lincoln with minors in Entomology and Entrepreneurship in 2015. From there, she worked at Walt Disney World in hydroponic production and edible landscaping. In 2016, she began her doctoral program at Texas A&M University. Melinda is a member of AFE's Young Professionals Council, a 2017 AmericanHort Scholar, and a member of the American Society of Horticultural Sciences. She is currently serving as the Texas A&M University Women in Ag Science's Co-Chair.